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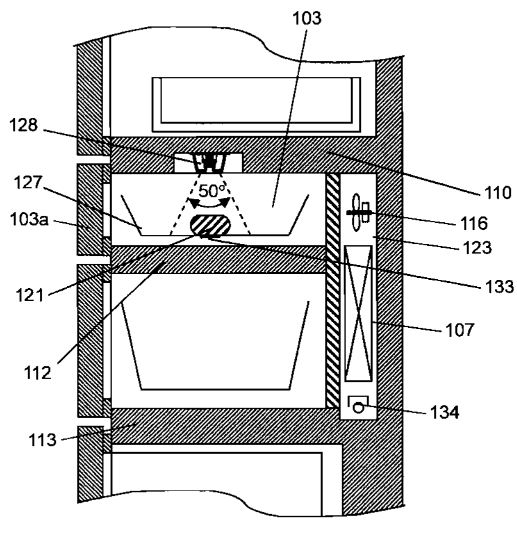
(54) **REFRIGERATOR**

(57) There is provided a storage room in which an infrared sensor detecting a surface temperature of a food is installed, and an adjacent storage room which is adjacent on a projection surface of a detection surface of the infrared sensor starting from the infrared sensor, an improvement of precision of a detection temperature at a time of opening and closing a door can be achieved by setting the storage room and the adjacent storage room to the same temperature zone, and a temperature of the food can be stably detected by suppressing a dew condensation and a temperature fluctuation of a thermistor itself which are factors of an erroneous detection.

FIG. 3



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Description

TECHNICAL FIELD

[0001] The present invention relates to a refrigerator utilizing a non-contact sensor.

BACKGROUND ART

[0002] In recent years, with an increase in demand for a high capacity refrigerator, a refrigerator capable of improving volume efficiency by reducing invalid spaces and a refrigerator having various layouts from a viewpoint of usability have been released.

[0003] In such refrigerators, in order to detect an inside temperature, an inside air temperature is conventionally measured by a thermistor and the like. For example, when a hot food is put in the refrigerator, the inside air temperature warmed by this hot food is measured by a plurality of thermistors installed inside the refrigerator, to thereby adjust a cooling quality. However, in such a kind of refrigerator, an actual temperature of the food is not measured, and therefore it is uncertain whether the food can be actually cooled. Therefore, in cooling the food, the food is cooled to a target temperature while cooling the circumference, thus involving a problem that time is required for cooling the food itself to a target temperature. Accordingly, for example by installing a non-contact infrared sensor inside refrigerator, or by using a load sensor attached under a case for arranging food to directly measure the temperature of the food, the temperature of an actual food is detected and cooling operation is performed (for example, refer to Patent Documents 1 and 2).

[0004] Conventional refrigerators of Patent Documents 1 and 2 will be described below with reference to the drawings.

[0005] FIG. 12 is a side vertical section view of a refrigerator described in Patent Document 1, and FIG. 13 is a partially expanded side section view thereof, wherein inside of refrigerator body 1 formed of a thermally insulated box body is set as a storage space, with refrigerating room 2 disposed in an uppermost section, vegetable room 6 disposed in a lower section, and freezing room 8 disposed in a lowermost section, respectively, independently of one another, and switching room 9 and an ice making room (not shown) disposed next to each other with a thermally insulated partition wall interposed therebetween between refrigerating room 2 and vegetable room 6, and an exclusive door provided to a front opening of each storage room, to openably close the opening.

[0006] Freezing room 8, switching room 9, freezing cooler 14 such as an ice making room, and cold air ventilation fan 16 for circulating cold air generated by freezing cooler 14 in the storage room are disposed in a back part of vegetable room 6. Further, refrigerating cooler 15 for cooling refrigerating room 2 and vegetable room 6 and a fan (not shown) are provided to a front position of freezing cooler 14. Then, refrigerant is alternately or simultaneously flown to freezing and refrigerating coolers 14 and 15 by driving compressor 17 installed in a lower part of a main body and by controlling a switch of a flow channel switching valve (not shown) of the refrigerant. Then, the cooled cold air is sent to each storage room at a frozen temperature zone side and a refrigeration temperature zone side by cold air ventilation fan 16, to thereby control the temperature to be cooled to a predetermined temperature.

[0007] Cold air of a low temperature discharged from freezing cooler 14 is branched into freezing room 8, the ice making room, and switching room 9 by cold air ventilation fan 16, which is then sent through an exclusive ventilation duct and cooled.

[0008] Under control of switching room 9, cold air is blown-out into each room from cold air blow-out port 20, and the temperature of food 21, being a load cooled by this cold air, is detected by infrared sensor 28 attached to a top panel, and by driving a freezing cycle to set the temperature to a previously set temperature and by performing opening and closing control of cold air dumper 32 installed near cold air blow-out port 20, introduction amount of cold air into each room is adjusted so that the temperature of food 21, being a foodstuff, is set to a predetermined temperature.

[0009] Thus, by detecting a surface temperature of food 21, being a detecting object, by infrared sensor 28, and by performing only a required amount of cooling drive when required, efficient cooling drive control is performed.

[0010] Next, another conventional refrigerator will be described.

[0011] FIG. 14 is a perspective view showing inside of a storage room of the refrigerator described in Patent Document 2, and FIG. 15 is a front view showing inside of a freezing room of the refrigerator described in Patent Document 2.

[0012] As shown in the figure, in another conventional refrigerator, whether storing of food, namely, charging load is present or absent is decided based on a temperature variation of load temperature sensor 39 disposed at a bottom of freezing room 8. When it is determined that the load exists, the temperature of the food and a size of the load are detected by load temperature sensor 39. Then, based on the detected temperature and variation of the temperature, when it is determined that the load exists, rapid freezing operation is started by the cold air flown into freezing room 8.

[0013] With this structure, unnecessary rapid freezing operation can be controlled to be avoided, by deciding a rapid freezing time according to the size of the load of the stored food.

[0014] Thus, according to a conventional technique, the temperature of the food, being the detecting object, is detected by load temperature sensor 39 provided to lower part of case 41 of a food mounting portion, then automatic rapid freezing is started or ended, and only required amount of cooling drive is performed when required, to thereby perform efficient cooling drive control.

[0015] However, in such a conventional structure according to Patent Document 1, infrared sensor 28 installed on a ceiling part of switching room 9 detects the temperature of food 21 when a door is closed, and cold air generated by freezing cooler 14 is controlled by opening and closing cold air dumper 32 based on the detected temperature of food 21 so that the introduction amount of the cold air into each room is adjusted. Thus, the temperature of food 21 is controlled to a predetermined set temperature. However, when the door is opened, detection of infrared sensor 28 strays from food 21 and is directed toward a thermally insulated partition portion on a projected surface. The temperature of the thermally insulated partition portion is different from the temperature of switching room 9 under an influence of the temperature caused by heat conduction from vegetable room 6 in the lower part. Therefore, infrared sensor 28 detects the temperature different from the temperature of the food cooled corresponding to the temperature of switching room 9. In other words, a part detected by infrared sensor 28 is subjected to sudden temperature variation when the door is opened. Specifically, when conventional switching room 9 is set to a frozen temperature and the door is opened only for confirming food 21 stored in switching room 9, infrared sensor 28 detects the temperature erroneously as the temperature at the time of putting in the food 21, and therefore cooling is started, thus involving a problem that switching room 9 is excessively cooled and useless energy is required.

[0016] In order to solve the above-described problems, there is a method of providing a switch function for detecting open/close of a door. However, during open/close of the door, interlocking control is necessary between the detection by infrared sensor 28 and switch control. Therefore, there is a problem that a complicated control is invited and an erroneous operation factor is possibly increased.

[0017] Further, when droplets are adhered to a leading end portion of infrared sensor 28 due to dew condensation water, etc, infrared sensor 28 detects the droplets without detecting food 21. Therefore, for example, there is also a method of providing a shutter mechanism in a sensor part of infrared sensor 28, for preventing dew condensation of a detected part of the leading end of the sensor due to flow of warm air from outside when the door is opened or closed. However, the shutter mechanism has a complicated mechanical structure, and therefore there is a high possibility that the erroneous operation factor is increased. Particularly, in the storage room of the refrigerator set at a low temperature, a problem such as reduction of reliability and malfunction of the mechanical structure is easily generated due to deterioration of lubricity of lubricating oil, in a case of the aforementioned complicated mechanical structure, and such a problem is particularly remarkable in a room set to a frozen temperature zone. Further, there is also a problem that trouble in movable action is generated when the dew condensation is frozen or by frost, etc.

[0018] Moreover, in another conventional structure of Patent Document 2, although there is a constant effect, it is insufficient for energy saving which is an interest of a market toward global environment in recent years or demands for improving freshness keeping performance of the refrigerator.

[0019] This is because in order to perform long-term storage of the food while maintaining the freshness keeping performance of the food, it is important to rapidly pass a temperature zone of 0°C to -5°C called a maximum frozen crystal creating range when the food is cooled so that cell destruction is prevented, therefore rapid freezing operation is performed by indirect cooling by cold air, and accordingly there is a limit in increasing a speed for passing the maximum frozen crystal creating range of 0°C to -5°C.

[0020] Further, when the rapid freezing operation is performed, introduction amount of the cold air into freezing room 8 is increased by setting a compressor and a cold air ventilation fan in a continuous operation mode to be rapidly frozen. Therefore, since freezing capacity of the refrigerator is enhanced for a certain period of time, power input of the refrigerator is considerably increased, thus requiring further use of energy, although a freezing rate is more increased than normal cooling. Therefore, the rapid freezing operation with energy saving taken into consideration is hardly performed.

[0021] Further, in the method of detecting the temperature of the food directly, the temperature of case 41 in contact with the food is detected by load temperature sensor 39 during rapid freezing, by disposing load temperature sensor 39 at the bottom of case 41, being a container in which foods are arranged, according to another conventional example described in Patent Document 2. This makes it difficult to rapidly detect the temperature of the food itself, and the temperature of the food is detected for the first time, only when heat conduction occurs from the food to case 41, and the temperature of the food and the temperature of the case itself are almost identical to each other. Therefore, there is a problem that detection time is delayed.

[0022] Further, the cooling time is required for not only the food, but also the load of the food other than the food desired to be cooled contained in case 41. In this case, as to a rapid freezing time, continuous operation mode is set for actual food 21 only, resulting in allowing useless cooling energy to occur.

[0023] In order to solve the above-described problems, the present invention has been made, and the present invention provides a refrigerator capable of eliminating erroneous detection of a non-contact sensor by a simple method without using a complicated method, and also capable of performing efficient cooling drive while saving energy, by having the non-contact sensor that performs detection of temperature in a storage room of the refrigerator with higher accuracy. Further, the present invention provides the refrigerator capable of rapidly starting automatic rapid cooling for the food put into the refrigerator and capable of further improving energy saving for performing rapid cooling that realizes further energy saving and also achieving good usability.

[Patent Document 1] Unexamined Japanese Patent Publication No. 2007-212053
[Patent Document 2] Japanese Patent No. 3454522

DISCLOSURE OF THE INVENTION

[0024] A refrigerator of the present invention includes:

a thermally insulated box body which is constructed by a plurality of temperature zones partitioned by a plurality of thermally insulated compartments;
a storage room which is defined such that the room is thermally insulated in the thermally insulated box body and in which a non-contact sensor for detecting a temperature of a food is installed; and
an adjacent storage room which is adjacent to the storage room, on a projection line in a direction in which the non-contact sensor detects, the projection line starting from the non-contact sensor of the storage room, wherein
the storage room in which the non-contact sensor is installed, and the adjacent storage room are set in the same temperature zone, or the adjacent storage room is set in a lower temperature zone than the storage room in which the non-contact sensor is installed.

[0025] With this structure, erroneous detection of the non-contact sensor due to thermal effect of high temperature, which is caused by the high temperature of the adjacent storage rooms in a detecting direction of the non-contact sensor, can be prevented. In addition, even in a case where an inclusion such as food or food storage container does not exist between the non-contact sensor and a partition wall of the adjacent storage rooms, the vicinity of the same temperature zone of the storage room and the adjacent storage room or the temperature zone of the adjacent storage room lower than the storage room is detected, thus making it possible to suppress the erroneous detection by the non-contact sensor such that the food of high temperature is put.
[0026] Even in a case where the inclusion does not exist between the non-contact sensor and the partition wall of the adjacent storage rooms, the refrigerator of the present invention is capable of suppressing the erroneous detection of the non-contact sensor. Therefore, the present invention achieves the refrigerator having the non-contact sensor capable of performing high quality temperature detection with high accuracy.
[0027] Further, the present invention provides the refrigerator including:

a storage room in which a non-contact sensor for detecting a surface temperature of a food placed on a food mounting portion is installed;
cooling means for cooling the storage room; and
rapid freezing control means for cooling the storage room with a high cooling capacity, wherein
the food mounting portion has a heat storage function, a rapid freezing control is automatically started by the rapid freezing control means for cooling with the high cooling capacity if the temperature detected by the non-contact sensor is higher than a previously set start temperature, and the rapid freezing control by the rapid freezing control means is stopped at a time point at which the temperature reaches a previously set end temperature.

[0028] With this structure, the temperature of the food is detected by the sensor for detecting the temperature in a non-contact state and the rapid freezing control is automatically started, and when the temperature reaches an end point, an operation is rapidly moved to a normal cooling operation. Therefore, automatic rapid cooling is speedily started for the food put into the refrigerator, and rapid cooling is achieved by directly depriving heat by heat conduction, because the food mounting portion has the heat storage function and such a food mounting portion cooled to a previously set frozen temperature zone is brought into contact with the food. Therefore, even in a case where the rapid freezing is controlled, continuous driving time of the compressor and the cold air ventilation fan can be tremendously shortened, and the rapid cooling capable of realizing further energy saving is achieved.
[0029] Further, from the viewpoint of preserving the food, the food mounting portion has the heat storage function for controlling rapid freezing of the present invention, thereby making it possible to perform heat transmission by introduction of the cold air by controlling rapid freezing and by heat conduction from the food mounting portion having the heat storage function, and realizing rapid cooling by using both the heat transmission and heat conduction. Therefore, a transit time of the maximum frozen crystal creating range of 0°C to -5°C that greatly affects the freshness particularly in a case of a frozen storage, can be further shortened. Then, by passing the maximum frozen crystal creating range in a short time, drips from the food can be reduced when the food is defrosted, thus making it possible to preserve the food without losing the freshness and taste. Therefore, a high storage quality of the food can be achieved.

[0030] As described above, the refrigerator of the present invention is capable of eliminating the erroneous detection of the non-contact sensor by a simple method without using a complicated method. This contributes to realizing an efficient cooling drive of the refrigerator and rapid cooling that attains energy saving, and also improving the storage quality of the frozen food. Thus, the refrigerator with higher storage quality that attains further energy saving can be provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031]

FIG. 1 is a front view of a refrigerator according to Embodiment 1, Embodiment 4, and Embodiment 7 of the present invention.
FIG. 2 is a side section view of the refrigerator according to the Embodiment 1, Embodiment 4, and Embodiment 7 of the present invention.
FIG. 3 is a partially expanded side section view of an upper stage freezing room according to Embodiment 1 of the present invention.
FIG. 4 is a partially expanded side section view of an upper stage freezing room according to Embodiment 2 of the present invention.
FIG. 5 is a partially expanded side section view of an upper stage freezing room according to Embodiment 3 of the present invention.
FIG. 6 is a partially expanded side section view of an upper stage freezing room according to Embodiment 4 of the present invention.
FIG. 7 is a partially expanded side section view of an upper stage freezing room according to Embodiment 5 of the present invention.
FIG. 8 is a partially expanded side section view of an upper stage freezing room according to Embodiment 6 of the present invention.
FIG. 9 is a partially expanded side section view of an upper stage freezing room of a refrigerator according to Embodiment 7 of the present invention.
FIG. 10 is a partially expanded side section view of a refrigerator according to Embodiment 8 of the present invention.
FIG. 11 is a side section view of a refrigerator according to Embodiment 9 of the present invention.
FIG. 12 is a side section view for illustrating a refrigerator according to a conventional art.
FIG. 13 is a partially expanded side section view for illustrating a refrigerator according to the conventional art.
FIG. 14 is a perspective view showing inside of a storage room of a refrigerator according to another conventional art.
FIG. 15 is a front view showing inside of a freezing room of a refrigerator according to another conventional art.

REFERENCE MARKS IN THE DRAWINGS

[0032]

102	Refrigerating room (reserve room)
103, 203, 303	Upper stage freezing room (storage room)
105, 205, 305	Lower stage freezing room (storage room)
107	Cooler
110	First thermally insulated partition portion (thermally insulated partition portion)
121,221,421	Food
127, 227, 427	Case (upper stage freezing room)
128, 228, 328, 425	Infrared sensor (non-contact sensor)
133,233	Mark
142, 242, 426	Cool storage medium (food mounting portion)
432	First discharge port
433	Second discharge port
434	Discharge duct
435	Downward discharge port

PREFERRED EMBODIMENTS FOR CARRYING OUT OF THE INVENTION

[0033] A refrigerator of the present invention includes:

a thermally insulated box body which is constructed by a plurality of temperature zones partitioned by a plurality of thermally insulated compartments;
a storage room which is defined such that the room is thermally insulated in the thermally insulated box body and in which a non-contact sensor for detecting a temperature of a food is installed; and
an adjacent storage room which is adjacent to the storage room, on a projection line in a direction in which the non-contact sensor detects, the projection line starting from the non-contact sensor of the storage room, wherein
the storage room in which the non-contact sensor is installed, and the adjacent storage room are set in the same temperature zone, or the adjacent storage room is set in a lower temperature zone than the storage room in which the non-contact sensor is installed.

[0034] With this structure, erroneous detection of the non-contact sensor due to thermal effect of high temperature, which is caused by the high temperature of the adjacent storage rooms in a detecting direction of the non-contact sensor, can be prevented. In addition, when an inclusion such as a food or a food storage container does not exist between the non-contact sensor and a partition wall of the adjacent storage rooms, even if the temperature of the adjacent storage room and the partition wall is detected, the vicinity of the same temperature zone of the storage room and the adjacent storage room, or the temperature zone of the adjacent storage room lower than the storage room is detected, thus making it possible to suppress the erroneous detection by the non-contact sensor such that the food of high temperature is put in.

[0035] Further, particularly in a case of the drawer type storage room, inclusion no including matters such as a food and a food storage container exist between the non-contact sensor and the partition wall of the adjacent storage rooms when a door is opened. Even in such a case, the non-contact sensor detects the vicinity of the same temperature as the temperature of the storage room or a lower temperature than the temperature of the storage room. Therefore, the erroneous detection can be suppressed when the door is opened or closed.

[0036] Further, in addition to the above-described invention, the present invention provides the refrigerator, wherein the non-contact sensor is an infrared sensor, with this infrared sensor installed in a portion at a relatively higher temperature in the storage room.

[0037] With this structure, moisture or water contained in warm air generated during opening and closing the door or by defrosting, and warm air generated from a load, not easily form dew condensation and frosting on the infrared sensor. In other words, a temperature difference is small between a peripheral part of the infrared sensor and the warm air, and therefore difference in relative humidity is also small even if absolute humidity is the same, thus making it difficult to form the dew condensation and frosting. Thus, owing to the dew condensation and frosting or freezing caused by a cooling drive after dew condensation and frosting, temperatures of water, frost, and ice adhered to the infrared sensor other than the temperature of the food is detected, and deterioration of accuracy can be reduced. Thus, the erroneous detection can be further suppressed. In addition, there is a great difference in temperatures between the detected food and an infrared sensor portion, thus increasing heat transfer amount by radiation, increasing infrared amount detected by the infrared sensor, and increasing a difference between a noise of the infrared sensor and a noise caused by a slight temperature fluctuation such as a temperature fluctuation caused by cooling a circulation fan in the room. This makes it possible to easily detect the temperature and accurately detect the surface temperature of the food.

[0038] Further, in addition to the above-described invention, the present invention provides the refrigerator, wherein a reserve room set in a higher temperature zone than the temperature zone of the adjacent storage room is provided, and the infrared sensor is installed in the vicinity of the reserve room.

[0039] With this structure, heat from the reserve room of high temperature has no small effect on an infrared sensor portion, thus raising the temperature of this portion higher than other portion, and therefore the dew condensation and frosting can be suppressed. Thus, decrease of accuracy can be suppressed, by detecting the temperatures of the water, frost, and ice adhered to the infrared sensor other than the temperature of the food, which are caused by the dew condensation and frosting, or freezing by the cooling drive after the dew condensation or frosting. Therefore, the erroneous detection can be further suppressed. In addition, by always maintaining a state that the dew condensation is hardly produced, the dew condensation of a detected part of the sensor is reduced. Thus, the erroneous detection of detecting a droplet temperature other than the temperature of the food can be prevented, and a product service life can be prolonged by maintaining a state of hardly allowing the droplet to be adhered to the infrared sensor, becoming a cause for deteriorating the service life. Further, a great difference can be taken in temperatures between the detected food and the infrared sensor portion, and therefore accuracy of sensor detection can be improved.

[0040] Further, in addition to the above-described invention, the present invention provides the refrigerator, wherein the infrared sensor is installed in a thermally insulated partition portion defining the storage room and the reserve room with thermal insulation.

[0041] With this structure, the infrared sensor is easily affected by the heat from the reserve room, and the dew condensation and frosting can be further suppressed and the deterioration of the accuracy can be suppressed. In addition, exposure of a detection part of the infrared sensor to inside of the storage room can be suppressed. Thus, the infrared sensor is hardly affected by the temperature fluctuation caused by the cold air flowing through the room, and a deviation of a detected temperature can be reduced.

[0042] Further, in addition to the above-described invention, the present invention provides the refrigerator, wherein a leading end of the infrared sensor is installed on a surface of the thermally insulated partition portion or an inner side of the surface.

[0043] With this structure, the leading end of the infrared sensor is not protruded, and therefore even in a case where a large volume of food is put into the storage room or at the time of cleaning, foreign matters are not adhered to the detection part of the infrared sensor. Accordingly, erroneous operation is not invited in detection. Further, since the leading end of the infrared sensor is not protruded in refrigerator, the capacity of the refrigerator can be secured.

[0044] Further, in addition to the above-described invention, the present invention provides the refrigerator, wherein by setting the temperature zone of the storage room in which the infrared sensor is installed, to the frozen temperature zone, the difference in temperatures between the temperature of the detected food and a reference temperature (thermistor temperature) of the infrared sensor becomes large, thus making it possible to further accurately detect the temperature.

[0045] Further, in addition to the above-described invention, the present invention provides the refrigerator, wherein a viewing angle at which the infrared sensor detects is set to 55° or less. Thus, by narrowing the viewing angle of the infrared sensor, detection accuracy is enhanced and insufficient cooling is prevented. For example, if the angle is taken wider, a temperature detection surface, in which the temperature is detected by the infrared sensor, becomes also wider. Thus, there is a high possibility of detecting the temperature other than the surface on which the food is placed, or the possibility that the food other than the food desired to be detected exists on a temperature detected surface. Thus, there is a possibility that the temperature excluding the temperature of a target food becomes noise, resulting in deterioration of the accuracy. However, the deterioration of the accuracy is prevented, because the viewing angle is narrowed to 55°C or less in the present invention.

[0046] Further, in addition to the above-described invention, the present invention provides the refrigerator, wherein a field of view of a surface detected by the infrared sensor is provided with a mark which is smaller than the field of view, thus making it possible to store the food in a range surely detectable by the infrared sensor.

[0047] Further, the present invention provides the refrigerator, including:

a storage room in which a non-contact sensor for detecting a surface temperature of a food placed on a food mounting portion is installed;
cooling means for cooling the storage room; and
rapid freezing control means for cooling the storage room with a high cooling capacity, wherein
the food mounting portion has a heat storage function, a rapid freezing control is automatically started by the rapid freezing control means for cooling with the high cooling capacity if the temperature detected by the non-contact sensor is higher than a previously set start temperature, and the rapid freezing control by the rapid freezing control means is stopped at a time point at which the temperature reaches a previously set end temperature.

[0048] With this structure, the temperature of the food is detected by the sensor for detecting the temperature in a non-contact state and the rapid freezing control is automatically started, and when the temperature reaches an end point, an operation is rapidly moved to a normal cooling operation. Therefore, automatic rapid cooling is speedily started for the food put into the storage room, and rapid cooling is achieved by directly drawing heat by heat conduction, because the food mounting portion has the heat storage function and such a food mounting portion cooled to a previously set frozen temperature zone is brought into contact with the food. Therefore, even in a case where the rapid freezing is controlled, continuous driving time of the compressor and the cold air ventilation fan can be tremendously shortened, and the rapid cooling capable of realizing further energy saving is achieved.

[0049] Further, from the viewpoint of preserving the food, the food mounting portion has the heat storage function for controlling rapid freezing of the present invention, thereby making it possible to perform heat transmission by introduction of the cold air by controlling rapid freezing and by heat conduction from the food mounting portion having the heat storage function, and realizing rapid cooling by using both the heat transmission and heat conduction. Therefore, the transit time of the maximum frozen crystal creating range of 0°C to -5°C that greatly affects the freshness particularly in a case of a frozen storage, can be further shortened. Then, by passing the maximum frozen crystal creating range for a short time, drips from the food can be reduced when the food is defrosted, thus making it possible to preserve the food without losing the freshness and taste, thereby achieving a high storage quality of the food.

[0050] As described above, improvement of the cooling capacity is carried out automatically, and therefore the refrigerator can be cooled by a cooling drive as needed. Particularly, as a countermeasure against the increase of the temperature inside of the room under an influence of charging the load, or in order to cool the load desired to be rapidly frozen, driving time of the refrigerator can be shortened out of 24 hours driving time, by short time cooling with high cooling capacity, rather than slowly cooling the load by driving a compressor with a medium rotation of about 40 Hz as conventional. Therefore, power consumption can be reduced, and also an exhaust quantity of greenhouse effect gas can be effectively restrained, which is a factor of worsening the global environment.

[0051] Further, although conventionally rapid freezing is controlled manually for the food desired to be frozen rapidly, the rapid freezing is controlled automatically in the present invention. Therefore, troublesome operation of controlling rapid freezing after putting in the food can be eliminated. In some of the refrigerators of recent years, in order to operate rapid freezing, the rapid freezing control needs to be selected and determination motion needs to be selected. Therefore, the rapid freezing operation itself is considered to be troublesome. However, according to the present invention, the rapid freezing is automatically controlled and cooling operation of the food is controlled by automatic cooling drive with high capacity. Therefore, a case that a user forgets to control rapid freezing does not occur.

[0052] Further, when the user comes back home from shopping and stores the food in the refrigerator for keeping fresh food such as meat in a freezer, the temperature inside the refrigerator is increased under an influence of open/close of the door. In this case, conventionally rapid freezing is not controlled automatically, and therefore time is required for cooling the food with low cooling capacity. However, according to the present invention, the rapid freezing can be automatically controlled when the temperature is high, depending on the temperature detected by the non-contact sensor. Therefore, the food can be rapidly cooled without requiring time, with high cooling capacity. As a result, the cooling time for cooling the food can be shortened and degradation of the freshness can be suppressed, because the temperature rise of the food itself can be suppressed by short time cooling.

[0053] Further, the rapid freezing control is automatically canceled when the food is frozen, and therefore, unlike the conventional art, wasteful energy consumption by unnecessary cooling drive after freezing can be eliminated. Moreover, in some of the conventional refrigerators, transition from a latent heat change to a sensible heat change of the food is detected and completion of freezing is determined based on the detection. However, in a case of showing equivalent change amount from the latent heat change to the sensible heat change depending on a size of the food, the completion of the freezing is hardly determined. However, according to the present invention, the temperature of the food itself is detected, and therefore freezing can be surely determined. Therefore, unlike the conventional art, complicated differential calculation control specification needs not to be constructed for calculating a change ratio of the food.

[0054] Further, in addition to the above-described invention, the present invention provides the refrigerator, wherein the non-contact sensor is the infrared sensor, and is provided in a storage room wall surface in an opposite side to the food mounting portion, and the storage room is a freezing room which is settable only in a frozen temperature zone.

[0055] With this structure, generally the infrared sensor has characteristics that detection accuracy is deteriorated as the infrared sensor is installed far away from a temperature zone where the accuracy is set highest. However, since the storage room in which the infrared sensor is installed corresponds to the freezing room, the temperature can be previously set highest in the vicinity of the frozen temperature zone, and is not set in other temperature zone. Therefore, the temperature of the food can be always detected with good accuracy, and further accurate start and end of the rapid freezing operation can be controlled. Thus, the rapid freezing realizing further energy saving can be controlled.

[0056] Further, by directly detecting a food temperature, the temperature of the food desired to be rapidly frozen can be detected in real time, thus making it possible to rapidly and accurately start and end the rapid freezing control, and control the rapid freezing that realizes further energy saving.

[0057] Further, in addition to the above-described invention, the present invention provides the refrigerator, wherein the temperature zone in which the rapid freezing control is automatically started by the rapid freezing control means includes a detection temperature between 0°C and -5°C in the temperature detected by the infrared sensor.

[0058] With this structure, the temperature can be controlled, by passing the maximum frozen crystal creating range of 0°C to -5°C for a short time, which has a great influence on frozen storage of the food. Therefore, it is possible to suppress the deterioration of the taste of the food and the deterioration of quality by suppressing a destruction of a tissue structure. As a result, drips from the food can be suppressed at the time of defrosting, and therefore the food can be preserved without losing the freshness and taste.

[0059] Preferred embodiments of the present invention will be described below with reference to the drawings. Note that the present invention is not limited by the embodiments.

(Embodiment 1)

[0060] FIG. 1 is a front view of a refrigerator according to Embodiment 1 of the present invention. FIG. 2 is a side section view of the refrigerator according to Embodiment 1 of the present invention. FIG. 3 is a partially expanded side section view of an upper stage freezing room according to Embodiment 1 of the present invention.

[0061] As shown in FIGS. 1 to 3, refrigerator main body 101 is a thermally insulated box body composed of outer box 124 made of metal (such as iron plate) opening frontward, inner box 125 made of hard resin (such as ABS), and made of urethane heat insulating material 126 foamed and filled between outer box 124 and inner box 125, the thermally insulated box body including:

refrigerating room 102 provided at an upper part of the main body;
upper stage freezing room 103 provided below the refrigerating room;
ice making room 104 provided below refrigerating room 102 and in parallel with upper stage freezing room 103;
vegetable room 106 provided at a lower part of the main body; and
lower stage freezing room 105 provided between upper stage freezing room 103 and ice making room 104 provided in parallel with each other, and vegetable room 106. Front face parts of upper stage freezing room 103, ice making room 104, lower stage freezing room 105, and vegetable room 106 are respectively openably closed by drawer type doors 103a, 104a, 105a, and 106a respectively, and a front face of refrigerating room 102 is openably closed by door 102a (not shown), being a double-hinged door 102a.

[0062] Refrigerating room 102 is set normally between 1°C and 5°C for storing under freeze while setting an ice-free temperature to a lower limit. It is often the case that vegetable room 106 is set between 2°C and 7°C which is a set temperature equal to or slightly higher than refrigerating room 102. If it is set to a low temperature, it is possible to maintain a freshness of a leaf vegetable for a long period. Upper stage freezing room 103 is normally set between -22 and -18°C for storing under freeze. However, depending on a frozen storage state preferred by a user, upper stage freezing room 103 can also be set to a soft frozen temperature zone around -7°C in which labor in cooking such as defrosting can be saved. Then, in order to further improve the frozen storage state, the temperature is sometimes set in a low temperature frozen temperature zone in a range of -30°C to -25°C which is further lower than -22°C to -18°C, being a normal frozen temperature zone. The temperature of lower stage freezing room 105 is normally set in a range of -22°C to -18°C for controlling frozen storage. However, in order to further improve the frozen storage state, the temperature is sometimes set in a low temperature frozen temperature zone in a range of -30°C to -25°C which is further lower than -22°C to -18°C, being a normal frozen temperature zone.

[0063] Insides of refrigerating room 102 and vegetable room 106 are set to plus temperatures, and therefore are called refrigeration temperature zones. Further, insides of upper stage freezing room 103, lower stage freezing room 105, and ice making room 104 are set to minus temperatures, and therefore are called frozen temperature zones.

[0064] A top panel portion of refrigerator main body 101 is recessed stepwise toward a back face side of refrigerator main body 101, to form machine room 119 therein, and is constituted of a first top panel portion and a second top panel portion. Refrigerant is enclosed in a freezing cycle formed by successively annularly connecting compressor 117 disposed in the stepwise recessed portion, a drier (not shown) for removing moisture, a capacitor (not shown), a heat radiating pipe (not shown) for heat radiation, capillary tube 118, and cooler 107, so that cooling drive is carried out. In recent years, flammable refrigerant is frequently used as the refrigerant, in consideration of environment protection. Note that in a case of the freezing cycle in which a three-way valve and a changeover valve are used, such functional components can be disposed within the machine room.

[0065] Further, refrigerating room 102, ice making room 104, and upper stage freezing room 103 are partitioned by first thermally insulated partition portion 110.

[0066] Further, ice making room 104 and upper stage freezing room 103 are partitioned by second thermally insulated partition portion 111.

[0067] Further, ice making room 104, upper stage freezing room 103, and lower stage freezing room 105 are partitioned by third thermally insulated partition portion 112.

[0068] Second thermally insulated partition portion 111 and third thermally insulated partition portion 112 are components assembled after foaming refrigerator main body 101. Therefore, polystyrene foam is normally used as a heat insulating material. However, hard urethane foam may be used for improving heat insulating performance and rigidity, and in addition, further thinner compartment structure may be achieved by inserting a vacuum heat insulating material having high heat insulating property.

[0069] Further, by thinning or eliminating second thermally insulated partition portion 111 and third thermally insulated partition portion 112 by securing an operation part of a door frame, a cooled air passage can be secured, to thereby improve cooling capacity. In addition, a central part of second thermally insulated partition portion 111 and third thermally insulated partition portion 112 is hollowed out to form an air passage, thereby achieving reduction of materials.

[0070] Further, lower stage freezing room 105 and vegetable room 106 are partitioned by fourth thermally insulated partition portion 113.

[0071] Cooling room 123 is provided on a back face of refrigerator main body 101, and in cooling room 123, cooler 107 typically generating cold air of fins and flat heat transfer tubes is vertically disposed in upper and lower directions on the back face of lower stage freezing room 105 including a backward region of second and third thermally insulated partition portions 111 and 112, being thermally insulated partition walls. Further, cooler 107 is made of aluminum or copper.

[0072] Cold air ventilation fan 116 is disposed in the vicinity (for example upper space) of cooler 107, for sending the cold air generated by cooler 107 to each storage room of refrigerating room 102, ice making room 104, upper stage freezing room 103, lower stage freezing room 105, and vegetable room 106, by forcible convention system. In addition, radiant heater 134 made of glass tube, being a defrosting device for defrosting a frost adhered to cooler 107 and cold air ventilation fan 116 during cooling operation, is provided to a lower space of cooler 107. The defrosting device is not particularly limited, and a pipe heater attached firmly to cooler 107 may also be used, other than radiant heater 134.

[0073] Although cold air ventilation fan 116 is sometimes directly disposed in inner box 125, it is disposed in second thermally insulated partition portion 111 assembled after foaming, and block machining is applied to components, to thereby achieve reduction of a manufacturing cost.

[0074] Next, the structure of upper stage freezing room 103 will be described in which infrared sensor 128, being a non contact sensor is installed.

[0075] As shown in FIG. 3, infrared sensor 128 for detecting the temperature of food 121 is installed in first thermally insulated partition portion 110, being the top panel portion of upper stage freezing room 103, toward a direction (lower direction in a case of this example) in which the adjacent storage rooms exist on a projection surface of a surface detected by infrared sensor 128. A discharge port (not shown) and a return port (not shown) of the cold air are provided on a back face upper part of upper stage freezing room 103. The cold air generated by cooler 107 is discharged from the discharge port, and the cold air circulated through upper stage freezing room 103 is returned again to cooling room 123. As shown by this example, by installing infrared sensor 128 within the thermally insulated partition portion, infrared sensor 128 is hardly affected by the cold air discharged from the discharge port, and therefore detection accuracy can be improved. Further, a leading end portion of infrared sensor 128 is positioned inside or the same surface of/as the surface of the thermally insulated partition portion, thereby preventing foreign matters from adhering to a detection part of infrared sensor 128 even in a case of putting large volume of food 121 into the storage room or during cleaning. Therefore, erroneous operation of the detection is not invited. Further, no catch by inward protrusions in the refrigerator occurs during cleaning, and therefore missing or deviation, etc, of the components in a detecting direction due to addition of an excessive force can be prevented. Moreover, there is no protrusion inward, and therefore inner capacity is not reduced so that the capacity of the refrigerator is secured.

[0076] Further, case 127 in the storage room detected by infrared sensor 128 is provided with mark 133 showing that a detected range falls within a field of view detectable by infrared sensor 128, in consideration of easily recognizing a place by a client on which food 121 is placed. In addition, by marking case 127 with mark 133 in a smaller range than the field of view detected by infrared sensor 128, the temperature can be surely detected during storing food 121. Particularly, detection intensity of infrared rays is strongest in a central part of a range detected by infrared sensor 128, and is weaker toward an end of the detection range. Therefore, in order to increase the detection accuracy, case 127 is preferably provided with mark 133, with the center as a reference.

[0077] Regarding such a mark, when infrared sensor 128 is provided to the top panel side of upper stage freezing room 103, being the storage room including a drawer type door as described in this embodiment, it is difficult for the user to recognize the position of the food, namely, on which position the food should be placed when the food is put in a state that drawer type door 103a is opened. Therefore, the user can precisely place the food by mark 133, thus making it possible to improve the detection accuracy of infrared sensor 128.

[0078] Next, infrared sensor 128 used in this embodiment will be described. Infrared sensor 128 detects infrared rays emitted from a range of a detected surface by a thermopile (not shown) in a leading end thereof so as to convert into an electric signal. A probe (not shown), being a converging member, for narrowing down a detection range of infrared sensor 128 is provided around the thermopile, and the temperature is detected by calculating the temperature of a detected object in comparison with a voltage of a thermistor (not shown) set at a reference temperature disposed in a substrate portion. Within a circle of the detection range by infrared sensor 128, infrared ray detection intensity is strongest in the center, and is weaker toward the end portion. Therefore, the intensity of the infrared rays of the detection object can be increased by narrowing down the viewing angle of the thermopile, so that the temperature of an object can be surely detected. However, the viewing angle is partially overlapped with the leading end portion of the probe, and therefore the sensor is affected by the temperature of the leading end portion, resulting in the erroneous detection. Therefore, according to this embodiment, the viewing angle of the thermopile is set to 55° or less (for example 50° in FIG. 3).

[0079] In infrared sensor 128 used in this embodiment, the thermopile constituted of many thermocouples formed on a silicon substrate is used. Further, a probe portion is a molding in which alumina powder having excellent heat conductivity is used as a material. However, a molding with ceramic powder such as magnesia powder or aluminum nitride powder dispersed therein is also acceptable, provided that it is the material having excellent heat conductivity. Further, with regard to a sensing responsiveness of infrared sensor 128, when a resin type probe is used, the responsiveness is delayed. However, a specific weight can be reduced, thus exhibiting effect in reducing weight. By thinning a thickness of the resin type probe, a slight improvement in responsiveness is achieved, and also volume can be reduced. This contributes to reducing environmental load by saving materials. Regarding thinning in thickness, the same thing can be said for a metal material having excellent heat conductivity.

[0080] Thus, in order to improve the detection accuracy of infrared sensor 128, the viewing angle becomes narrower by having the probe, being the infrared ray converging member for narrowing down a detected range. However, by having the probe, the detection accuracy can be improved.

[0081] Further, the surface detected by infrared sensor 128 is formed of a material having a cold storing function.

Accordingly, temperature fluctuation of the detection surface itself is reduced, and therefore when a warm food is put in, the temperature can be further accurately detected.

[0082] Then, an operation and an action of the refrigerator constituted as described above will be described.

[0083] For example, when the temperature of the inside of refrigerating room 102 is increased by heat invasion from outside air or by opening and closing the door, and a refrigerating room sensor (not shown) indicates the temperature more than a starting temperature of compressor 117, compressor 117 is activated to start cooling operation inside of refrigerating room 102. The refrigerant of high temperature and high pressure discharged from compressor 117 is cooled and liquefied by heat exchange with air outside of outer box 124 and urethane heat insulating material 126 inside of outer box 124, through the heat radiating pipe (not shown) installed in a capacitor (not shown) or outer box 124 in particular, in a process to finally reach a drier (not shown) disposed in machine room 119.

[0084] Next, pressure of the liquefied refrigerant is reduced by capillary tube 118, which is then flown into cooler 107 to perform heat exchange with interior air around cooler 107. The cold air that has undergone heat exchange is blown out to inside by cold air ventilation fan 116 nearby, so that interior atmosphere is cooled. Thereafter, the refrigerant is heated and gasified, and is returned to compressor 117. When the interior atmosphere is cooled and the temperature of a freezing room sensor (not shown) indicates a stop temperature or less, the drive of compressor 117 is stopped.

[0085] The refrigerator carries out cooling drive by repeating the above-described drive cycle. At this time, when drawer type door 103a is closed, infrared sensor 128 detects the temperature of case 127 or the temperature of food 121 positioned within the upper stage freezing room, by thermopile 129 attached to the top panel of upper stage freezing room 103.

[0086] However, when the door is opened for putting in food 121 or taking out materials other than food 121, or for confirming stored food 121, detection of infrared sensor 128 is deviated from the surface of case 127 and the detection surface of target food 121, and the temperature of third thermally insulated partition portion 112 is detected, which is a partition wall for partitioning between the storage room positioned on the projected line in a detecting direction of infrared sensor 128, and the storage room in which infrared sensor 128 is installed. As conventional in a case of the refrigerator in which the adjacent storage rooms positioned on a projected surface of the surface detected by infrared sensor 128, namely, on the projected line in the detecting direction of infrared sensor 128, are set in a higher temperate zone than the frozen temperature zone by 20°C or more, a temperature difference is caused by heat conduction on the surface of third thermally insulated partition portion 112. Therefore, the temperature detected by infrared sensor 128 is suddenly changed rather highly, thus inviting the erroneous detection showing that warm food is put into the storage room.

[0087] However, according to this embodiment, temperature zones of the adjacent storage rooms with third thermally insulated partition portion 112 held between them are set as the same temperature zones or the adjacent storage room is set as a lower temperature zone than the storage room. Therefore, consumption of useless energy such that variation of the detected temperature becomes small and deviation in detection occurs, thus requiring unnecessary cooling capacity, then increasing the number of rotations of compressor 117 or increasing the number of rotations of cold air ventilation fan 116, can be prevented.

[0088] Particularly, as with the embodiment, in a case that the non-contact sensor is installed in a drawer type storage room, the non-contact sensor detects third thermally insulated partition portion 112, being a wall surface on the side of the projected surface when the door is opened, thus detecting the vicinity of the same temperature as the storage room or a lower temperature than the temperature of the storage room. Therefore, the adjacent storage rooms are not set to have higher temperatures during open/close of the door, thus making it possible to suppress the erroneous detection by the non-contact sensor such that the warm food is put in.

[0089] Further, conventionally by providing a door switch and causing interlocking motion with the switch, open/close state of the door is grasped, and when the door switch is started, infrared sensor 128 is set in an undetectable state. With this structure, the erroneous detection is prevented. However, by providing the door switch and causing interlocking motion with the switch, the structure is further complicated. Therefore, there is a possibility that malfunction or failure in operation is increased, and further, owing to addition of a control mechanism including the door switch and wiring, etc, for causing interlocking motion with the switch, a cost rise is considered to occur in a circumstance of escalating component prices due to global insufficient raw materials, thereby causing a cost increase in an actual sales.

[0090] However, in this example, for example, when the door is closed and food 121 is stored therein, the food of higher temperature than the temperature of the circumference is detected, and in an open state of the door, the temperature such as a lower temperature zone or the same temperature zone than/as the temperature of the storage room in which the infrared sensor is installed, is detected. Therefore, for example even in a case where the temperature is temporarily increased by opening the door, when the warm food is not actually put in, sudden temperature drop can be detected thereafter, and therefore by calculating a temperature gradient within a specific time period and providing a threshold value, it is possible to determine start of automatic rapid freezing only when the threshold value indicates a specific value or more. Thus, detection whether the temperature rise is caused by external disturbance is possible, only by setting a control specification with a simple structure without providing the door switch. Accordingly, as described above, an effect is expected as follows. Specifically, material resources can be saved and attachment error, etc, can be prevented during assembly of the components, with further high reliability.

[0091] Further, in a humid weather condition specific to Japan, when the door is opened, warm humidity of outside air is flown to inside the refrigerator. However, when the dew condensation is formed on the surface of infrared sensor 128, thermopile 129 detects the temperature of dew condensation water. Further when the door is closed and interior cooling drive is started, the dew condensation water is frozen, thus making it difficult to detect the temperature of the food by thermopile 129 until the frozen water droplet is sublimated. Therefore, in this embodiment, infrared sensor 128 is installed at the refrigerating room side to obtain an effect of preventing the dew condensation by disposing it in the thermally insulated partition portion that partitions the reserve room where the temperature is higher than the temperature of the adjacent storage room, and also installed closer to the door where the temperature is highest in a temperature distribution of the thermally insulated partition portion. A shutter mechanism can also be mounted as the conventional example, for preventing the dew condensation. However, in this case, interlocking motion with open/close of the door is required, thus requiring a complicated mechanism.

[0092] Further, by installing infrared sensor 128 at a part of the storage room where average temperature is higher than a surrounding temperature, a design, in which sticking of moisture hardly occurs, being a cause of aging deterioration, can be achieved. Therefore an effect of prolonging a product service life can be obtained.

[0093] Further, an object of this embodiment is to detect the temperature of food 121 by infrared sensor 128. In this case, simultaneously with detecting the temperature of food 121, infrared sensor 128 detects the temperatures of all materials within a field of view of infrared sensor 128, and therefore detects infrared rays emitted from a wall surface of the storage room or food 121 stored in the storage room. Therefore, when the temperature of a surface detected by infrared sensor 128 is increased by flow of warm air accompanied by open/close of the door, detection accuracy of detecting the temperature of food 121 by infrared sensor 128 is deteriorated. Accordingly, the surface detected by infrared sensor 128 has preferably a constant temperature and has a cold storing function in this embodiment. Thus, when the detected surface has the cold storing function, further constant temperature can be maintained within a detected range in an interior wall surface, etc. Therefore, it is possible to prevent such a case that the erroneous detection occurs, in which the food other than food 121 is put in, by flow of the warm air, etc, being the temperature rise due to a so-called external disturbance, and useless energy is consumed by excessively cooling the storage room by starting automatic rapid cooling because of this erroneous detection.

[0094] Further, when such an automatic rapid cooling is started, a temperature fluctuation by putting in the food cannot be discriminated from a temperature fluctuation by external disturbance other than putting in the food. Therefore, there is a possibility of the erroneous detection such that the temperature fluctuation by external disturbance is caused by putting in the food. Therefore, in order to prevent the detection by such an external disturbance, determination time is provided for determining whether the food is put in, as external disturbance detecting means for surely detecting the presence/absence of input food. Then when a warm temperature is detected, the putting in of food is surely determined by monitoring the temperature fluctuation of a constant determination time after detection of the warm temperature, and only when a high temperature is always detected during the determination time, automatic rapid cooling is started, so that the presence/absence of the input food is surely determined. Further, the determination time can also be started after elapse of a constant time from detecting the warm temperature, and particularly in a case of the temperature rise due to flow of the warm air, the temperature rapidly drops. Therefore, the temperature is detected again after elapse of a constant time, and only when a high temperature is detected, the automatic rapid cooling is started, so that the presence/absence of the input food is surely determined. Useless energy consumption by excessively cooling the storage room by starting automatic rapid cooling by erroneous detection can be prevented by providing the aforementioned external disturbance detecting means.

[0095] Further, when infrared sensor 128 is installed in the storage room, this embodiment gives consideration to installing infrared sensor 128 in the storage room, so that a surface of a sensor probe is disposed under the surface of the thermally insulated partition portion. With this structure, the temperature fluctuation during detection is reduced by not excessively cooling the leading end portion of the probe by the cold air from the cold air discharge portion the back face. In addition, with this structure, lack or detachment of components under action of excessive force can be suppressed, which is caused by catching the food or adhesion of foreign matters when more than allowable amount of food is stored, or by catching of the leading end of infrared sensor 128 by fingers or towel, etc, being a cleaning tool during cleaning.

[0096] Further, infrared sensor 128 erroneously detects when thermistor 131 detecting its own temperature generates an excessive temperature fluctuation. Therefore, infrared sensor 128 and thermistor 131 are set apart from each other, so that infrared sensor 128 is not exposed to temperature influence from a part where heat fluctuation occurs. A pipe mainly composed of a metal material such as copper or iron is arranged in the refrigerator, for releasing heat and preventing surface dew condensation. Therefore, in this embodiment, a distance from the pipe is set to 15mm or more.

[0097] As a countermeasure against dew condensation and freezing of the leading end portion of infrared sensor 128, there is a method of utilizing a heat of a heater. In this case, when a method of fixing a chip resistance to a substrate is used, a cost can be reduced. As a capacitance of the chip resistance, the temperature rise of the leading end of the probe can be sufficiently secured, if energization rate is about 20 minutes per day under voltage of 5 V toward a capacitance of about 0.25 W in a case of infrared sensor 128 of this embodiment. Further, a method of periodically refreshing by securely removing the dew condensation and the freezing by frequently as not every day but once in a month in a refrigerator of long use is also effective for prolonging the product service life.

[0098] As the refrigerant of a freezing cycle of recent years, isobutene, being a flammable refrigerant with a small global warming coefficient is used from a viewpoint of global environmental protection. Isobutane, being hydrogen carbide, has a specific gravity of about twice at a normal temperature and under atmospheric pressure, compared with air (under 2.04 and 300K). If the isobutene, being the flammable refrigerant, is leaked from the freezing system when compressor 117 stops, the isobutene leaks downward, because it is heavier than air. Particularly, when the isobutene is leaked from cooler 107 having much residual amount of the refrigerant, there is a possibility that a leak amount is increased. However, upper stage freezing room 103 with infrared sensor 128 installed therein, is set on an upper side of cooler 107, and therefore even in a case of the leak, the isobutene does not leak to upper stage freezing room 103. Also, even if the isobutene leaks to upper stage freezing room 103, it remains in a lower part of the storage room, because the refrigerant is heavier than air. Therefore, since infrared sensor 128 is installed on the top panel of the storage room, there is little possibility that the vicinity of infrared sensor 128 reaches a flammable concentration.

(Embodiment 2)

[0099] In this embodiment, detailed description of the same part as the structure and a technical concept as described in Embodiment 1 will be omitted. Regarding a similar technical concept as the content described in Embodiment 1, it is possible to achieve the structure obtained by combining with the technical content and the structure which are described in Embodiment 1.

[0100] FIG. 4 is a partially expanded side section view of a refrigerator according to Embodiment 2 of the present invention. As shown in FIG. 4, in this embodiment according to Embodiment 1, only container 227 is a surface detected by infrared sensor 228 installed in upper stage freezing room 203, and a third thermally insulated partition portion positioned on a lower side of container 227 is omitted. In this embodiment as well, a part of a food mounting surface whose temperature can be detected by infrared sensor 228 with highest accuracy, is provided with mark 233.

[0101] Specifically, by setting upper stage freezing room 203 and lower stage freezing room 205 in almost the same temperature zone, there is an advantage that the temperature fluctuation of the detected temperature can be further suppressed, because lower stage freezing room 205 is set in almost the same temperature zone as upper stage freezing room 203, even when the temperature of lower stage freezing room 205 is detected when the door is opened.

[0102] In addition, there is an advantage that the food mounting surface with the food of upper stage freezing room 203 mounted thereon, can be cooled from a lower side by the cold air for cooling lower stage freezing room 205, and therefore, the food mounting surface is cooled by the cold air at a low temperature from both upper and lower sides, thus making it possible to reduce temperature difference in a space of the upper side and the lower side of the food mounting surface, and this contributes to further suppressing the temperature fluctuation of the detected temperature by the infrared sensor. Also, there is an advantage that a cooling speed is tremendously increased more than a case that the third thermally insulated partition portion exists. Further, it is known that little cell destruction occurs if food 221 passes the maximum frozen crystal creating range of 0°C to -5°C for a short time during freezing. Therefore, it is extremely effective for preserving foods, when food 221 is cooled from upper and lower sides by eliminating the third thermally insulated partition portion.

(Embodiment 3)

[0103] In this embodiment, the description will be omitted for a part to which the same structure or the same technical concept as the technique described in Embodiment 1 or 2 can be applied. Regarding the structure to which the same technical concept as the contents described in Embodiment 1 or 2, it is possible to achieve the structure obtained by combining with the technical contents and the structure which are described in Embodiment 1 or 2.

[0104] FIG. 5 is a partially expanded side section view of a refrigerator according to Embodiment 3 of the present invention. In FIG. 5, infrared sensor 328 is installed in a door portion for drawing out upper stage freezing room 303, and when the door is opened or closed, the detected temperature, etc, is transmitted to a control part of refrigerator main body 301 by radio waves.

[0105] Thus, even when the door is opened for taking out food 321, the temperature of food 321 within case 327 can be surely detected. Therefore, this is effective for confirming a cooling speed or a freezing state of food 321. Note that in this embodiment, a data transmission method by radio waves is described, because the door is a drawer type door. However, in a case of an open type door, a wireless circuit can be reduced by arranging wiring for transmission in an action part of opening and closing the door.

(Embodiment 4)

[0106] In the present embodiment, a description of the same structures as the technique described in Embodiments 1 to 3 or the portions to which the same technical concepts are applied will be omitted. With regard the structures to which the same technical concepts as the contents described in Embodiments 1 to 3 can be applied, it is possible to achieve a structure obtained by combining with the technical contents and structures which are described in Embodiments 1 to 3.

[0107] FIG. 1 previously described is also a front view of a refrigerator according to Embodiment 4 of the present invention. In the same manner, FIG. 2 previously described is also a side section view of the refrigerator according to Embodiment 4 of the present invention. FIG. 6 is a partially expanded side section view of an upper stage freezing room in Embodiment 4 of the present invention.

[0108] As shown in FIGS. 1, 2 and 6, refrigerator main body 101 is a thermally insulated box body constructed by outer box 124 which is open forward and is made of metal (such as steel plate), inner box 125 which is made of hard resin (such as ABS), and urethane heat insulating material 126 which is foamed and filled between outer box 124 and inner box 125, and is constructed by refrigerating room 102 provided at an upper part of the main body, upper stage freezing room 103 provided below the refrigerating room, ice making room 104 provided below refrigerating room 102 and in parallel with upper stage freezing room 103, vegetable room 106 provided at a lower part of the main body, and lower stage freezing room 105 provided between upper stage freezing room 103 and ice making room 104 installed in parallel with each other, and vegetable room 106. Front face portions of upper stage freezing room 103, ice making room 104, lower stage freezing room 105 and vegetable room 106 are openably closed by drawer type doors (not shown), and a front face of refrigerating room 102 is openably closed by a door (not shown), for example, of a double-hinged door.

[0109] Refrigerating room 102 is set normally between 1 and 5 °C for storing under freeze while setting an ice-free temperature to a lower limit. It is often the case that vegetable room 106 is set between 2°C and 7°C which is a set temperature equal to or slightly higher than refrigerating room 102. If it is set to a low temperature, it is possible to maintain a freshness of a leaf vegetable for a long period. Upper stage freezing room 103 is normally set to a frozen temperature zone between -22°C and -18°C for storing under freeze, however, in some frozen storage state which is preferable for a user, it is possible to set to a soft frozen temperature zone in the vicinity of -7°C which can save the trouble of cooing such as defrosting or the like. Further, in order to improve a frozen storage state, it may be set to a low temperature frozen temperature zone, for example, between -30°C and -25°C which is further lower than the temperature between -22°C and -18°C corresponding to the normal frozen temperature zone. Lower stage freezing room 105 is normally set to the frozen temperature zone between -22°C and -18°C for the frozen storage, however, in order to improve the frozen storage state, it may be set to the low temperature frozen temperature zone, for example, between -30°C and -25°C.

[0110] Since refrigerating room 102 and vegetable room 106 are set their insides to plus temperatures, they are called as a refrigeration temperature zone collectively, and since upper stage freezing room 103, lower stage freezing room 105 and ice making room 104 are set their insides to minus temperatures, and they are called as a frozen temperature zone collectively.

[0111] A top surface portion of refrigerator main body 101 is provided with a stepped recess toward a back face direction of refrigerator main body 101 so as to form machine room 119, and is constructed by a first top surface portion and a second top surface portion. A cooling operation is carried out by sealing a refrigeration cycle obtained by sequentially connecting compressor 117 arranged in the stepped concave portion, a dryer (not shown) removing a water content, a condenser (not shown), a heat radiation pipe (not shown) for radiating heat, capillary tube 118, and cooler 107. It is often the case that a combustible cooling medium has been used in the cooling medium for an environmental protection, in recent years. In this case, in the case of the refrigeration cycle using a three way valve and a switch valve, these functional parts can be arranged within the machine room.

[0112] Further, refrigerating room 102, ice making room 104 and upper stage freezing room 103 are defined by first thermally insulated partition portion 110.

[0113] Further, ice making room 104 and upper stage freezing room 103 are comparted by second thermally insulated partition portion 111.

[0114] Further, ice making room 104, upper stage freezing room 103 and lower stage freezing room 105 are defined by third thermally insulated partition portion 112.

[0115] Since second thermally insulated partition portion 111 and third thermally insulated partition portion 112 are parts which are assembled after foaming refrigerator main body 101, a foamed polystyrene is used normally as the heat insulating material, however, a rigid urethane foam may be used for improving a heat insulating performance and a rigidity, and a further thinness of a compartment structure may be achieved by inserting a vacuum insulating material having a high heat insulating property.

[0116] Further, a cooling wind path can be secured and an improvement of a cooling capacity can be achieved, by securing an operation portion of a door frame so as to thin or abolish the shapes of second thermally insulated partition portion 111 and third thermally insulated partition portion 112. Further, a reduction of a material is achieved by hollowing out center portions of second thermally insulated partition portion 111 and third thermally insulated partition portion 112 so as to form a wind path.

[0117] Further, lower stage freezing room 105 and vegetable room 106 are defined by fourth thermally insulated partition portion 113.

[0118] Cooling room 123 covered with cooling room cover 122 is provided in a back face of refrigerator main body 101, specifically provided in a back face of upper stage freezing room 103 or lower stage freezing room 105. Within cooling room 123, fin and tube type cold air creating cooler 107 is arranged as a representative example in a back face of lower stage freezing room 105 including a rearward region of second and third thermally insulated partition portions 111 and 112 corresponding to the thermally insulated room wall so as to be longer than is wide in a vertical direction. Further, a material of cooler 107 employs aluminum or a copper.

[0119] Cold air ventilation fan 116 ventilating the cold air created by cooler 107 to each of storage rooms including refrigerating room 102, ice making room 104, upper stage freezing room 103, lower stage freezing room 105 and vegetable room 106 based on a forced convection method is arranged in the vicinity (for example, an upper space) of cooler 107, and radiant heater 134 made of a glass tube and serving as a defrosting device removing a frost attached to cooler 107 and cold air ventilation fan 116 at a time of cooling is provided in a lower space of cooler 107. The defrosting device is not particularly designated, but a pipe heater closely attached to cooler 107 may be used in addition to radiant heater 134.

[0120] Within cooling room cover 122, there is provided a duct ventilating the cold air from cold air ventilation fan 116 to each of the storage rooms, and it directly ventilate the cold air in cooler 107 to upper stage freezing room 103 and lower stage freezing room 105 through same discharge duct 434.

[0121] Further, discharge duct 434 is positioned closest to cooler 107 in the wind paths feeding the cold air to each of the storage rooms.

[0122] A front face of cooling room cover 122 is provided with first discharge port 432 and second discharge port 433 which respectively discharge the cold air to upper stage freezing room 103 and lower stage freezing room 105, and flow rates of first discharge port 432 and second discharge port 433 are distributed according to a load amount rate of two rooms. In the present embodiment, since a discharge area of upper stage freezing room 103 is about 3000 mm^2, and a discharge area of lower stage freezing room 105 is about 6000 mm^2, the same temperature zone is constructed by setting a rate of a flow rate of upper stage freezing room 103 and a flow rate of lower stage freezing room 105 to 1:2. Further, distances between an outlet of cold air ventilation fan 116 ventilating the cold air created by cooler 107, and first discharge port 432 of upper stage freezing room 103 and second discharge port 433 of lower stage freezing room 105 are set to the same through the same duct. In the present embodiment, they are set to 100 mm, thereby setting each of the discharge cold airs to the same temperature.

[0123] Further, since first discharge port 432 and second discharge port 433 are a discharge port having a shortest distance from cooler 107 and a discharge port having a second shortest distance, the cold air which just gets out of cooler 107 has a small thermal loss, thereby coming to the lowest temperature is discharged from first discharge port 432 and second discharge port 433. Therefore, the cold air is discharged at a higher cooling efficiency and having the same temperature in first discharge port 432 and second discharge port 433.

[0124] Cold air ventilation fan 116 may be directly arranged in inner box 125,however, it is possible to achieve a reduction of a manufacturing cost by arranging it in second thermally insulated partition portion 111 which is assembled after being foamed, and carrying out a block work of the parts.

[0125] Next, a description will be given of a structure of upper stage freezing room 103 to which infrared sensor 128 is attached.

[0126] As shown in FIG. 6, infrared sensor 128 corresponding to a non-contact sensor detecting a temperature of food 121 is installed in first thermally insulated partition portion 110 corresponding to a ceiling surface of upper stage freezing room 103 toward a direction (a downward direction in the present embodiment) in which an adjacent storage room on a plane of projection of the detected surface exists. A back face upper portion of upper stage freezing room 103 is provided with first discharge port 432 discharging the cold air to an inside room from cooling room cover 122, and a return port (not shown) for the cold air circulating within upper stage freezing room 103 again returning to cooling room 123. In this case, since it is possible to make infrared sensor 128 hard to be affected by the wind of the cold air discharged from first discharge port 432, by installing infrared sensor 128 within the thermally insulated partition portion, it is possible to achieve an improvement of a detection precision. Further, since any foreign material is not attached to a detection portion of infrared sensor 128 in the case that a large amount of foods 121 are entered into the storage room or even at a cleaning time, by setting a leading end portion of infrared sensor 128 inside or the same surface as the surface of the thermally insulated partition portion, an erroneous motion of the detection is not caused. Further, since there is no catch at a time of cleaning caused by a protrusion to the room inside, it is possible to prevent a lacking of part and a displacement in a detecting direction due to an application of an excessive force. Further, since no protrusion is provided within the room, a room inside capacity is not reduced and there is an advantage that the capacity can be secured.

[0127] In this case, if a mark indicating a field of view is provided around a position having a good detection precision of case 127 within the storage room detected by infrared sensor 128, a storage site of food 121 is easy to be known for a customer, and it is possible to securely detect the temperature at a time of storing food 121, by additionally setting mark 137 in a smaller range than the field of view detected by infrared sensor 128. Particularly, since infrared sensor 128 is structured such that a detection intensity of the infrared ray becomes strongest in a center portion of the detecting range and becomes weaker toward an end of the detection range, it is preferable to put mark 137 based on the center for enhancing the detection precision.

[0128] Next, a description will be given of infrared sensor 128 which is used in the present embodiment.

[0129] Infrared sensor 128 detects an amount of the infrared ray issued from the range of the detecting surface by a thermopile in a leading end thereof so as to convert into an electric signal. A probe is provided in the periphery of the thermopile, and a temperature detection is carried out by calculating a temperature of the detected subject by comparing with an electric voltage of the thermistor corresponding to a reference temperature arranged in a substrate portion. Infrared sensor 128 is structured such that an infrared ray detection intensity is strongest in a center and the detection intensity becomes weaker toward an end, in a circle inner portion of the detecting range. Accordingly, it is possible to increase the intensity of the amount of infrared ray of the detected subject by narrowing a viewing angle of the thermopile, and it is possible to securely detect the temperature of the subject. However, since a part of the viewing angle laps over the leading end portion of the probe, it is affected by a temperature of the leading end portion so as to cause an erroneous detection. Therefore, according to the present embodiment, the viewing angle of the thermopile is set to 50°, however, it is desirable that it is equal to or less than 55°.

[0130] Infrared sensor 128 used in the present embodiment employs the thermopile constructed by a lot of thermo couples formed on a silicon substrate. Further, a material of the probe portion is a molded product using alumina powder which is excellent in a thermal conductivity, however, any molded product obtained by dispersing a ceramic powder, for example, magnesia powder, aluminum nitride powder or the like may be employed as far as the material which is excellent in the thermal conductivity. Further, if a resin type probe is used in a detection response of infrared sensor 128, a delay is generated in a response, however, since a specific gravity can be reduced, it is effective for a weight saving. It is possible to achieve a slight improvement of the response by reducing a thickness in the resin type probe. Since it is possible to reduce a volume, it is possible to lower an environmental load by a material saving. Thinning is same applied to the metal material which is excellent in the thermal conductivity.

[0131] With regard to the refrigerator constructed as mentioned above, a description will be given below of a motion and an operation thereof.

[0132] In the case that the room inside temperature rises and a refrigerating room sensor (not shown) becomes a start temperature or more of compressor 117, for example, a heat intrusion from an ambient air or a door opening and closing in refrigerating room 102, compressor 117 is started and the cooling in the room is started. A high-temperature and high-pressure cooling medium discharged from compressor 117 is cooled and liquefied based on a heat exchange with the air outside outer box 124 and urethane heat insulating material 126 within the room, until finally reaching a dryer (not shown) arranged in machine room 119, particularly in a condenser (not shown) or a heat radiation pipe (not shown) installed in outer box 124.

[0133] Next, the liquefied cooling medium is depressurized by capillary tube 118, flows into cooler 107 and is heat exchanged with the room inside air in the periphery of cooler 107. The heat exchanged cold air is ventilated into the room by cold air ventilation fan 116 in the vicinity thereof so as to cool the room inside. Thereafter, the cooling medium is heated and gasified so as to be turned back to compressor 117. In the case that the room inside is cooled and the temperature of the freezing room sensor (not shown) becomes equal to or less than the stop temperature, the operation of compressor 117 is stopped.

[0134] The refrigerator carries out a cooling operation by repeating the operation cycles mentioned above. When the door is closed, infrared sensor 128 detects the temperature of case 127 or food 121 within the upper stage freezing room from the thermopile of infrared sensor 128 attached to the top surface of upper stage freezing room 103. However, in the case that the door is opened at a time of putting in food 121 or picking up the other material than food 121, or confirming stored food 121, infrared sensor 128 is detached from the surface of case 127 and the detection surface of target food 121, and detects the temperature of third thermally insulated partition portion 112 defining the storage room provided with infrared sensor 128 and the adjacent storage room. In the case that the adjacent storage room existing on the plane of projection of the surface detected by infrared sensor 128 is the cold temperature zone as conventionally, a temperature difference is generated in the surface of third thermally insulated partition portion 112 due to a thermal conduction, so that the detection temperature is changed rapidly to a higher side. In the present embodiment, since upper stage freezing room 103 and lower stage freezing room 105 are cooled by the discharge cold air which is discharged through same discharge duct 434 and has the same temperature, and the flow rate of the discharge cold air is distributed by a rate of the load amounts of upper stage freezing room 103 and lower stage freezing room 105, the temperatures of upper stage freezing room 103 and lower stage freezing room 105 come to the same temperature zone. Accordingly, third thermally insulated partition portion 112 coming to the detection portion of infrared sensor 128 in the case the door is opened comes to the same temperature as that of the detecting portion at a time when the door is closed, and it is possible to suppress an erroneous detection whether or not food 121 is put going with the door open and close. For example, in the case that a temperature adjustment of a predetermined temperature in upper stage freezing room 103 and lower stage freezing room 105 is carried out by controlling the discharge amount of the discharged cold air, the predetermined temperature is maintained by an average temperature of an upper limit temperature and a lower limit temperature in no small way. Accordingly, in the case of adjusting the temperature of both upper stage freezing room 103 and lower stage freezing room 105 by the discharge cold air having the same temperature such as the present invention, the upper limit temperature and the lower limit temperature of upper stage freezing room 103 are hard to be differentiated from those of lower stage freezing room 105. Therefore, since the upper limit temperatures and the lower limit temperatures going with the temperature adjustment come to approximately the same temperature between upper stage freezing room 103 and lower stage freezing room 105, and it is possible to further suppress the erroneous detection of infrared sensor 128, a change amount of the temperature detected by infrared sensor 128 becomes small even in the case that the door is opened, it is possible to prevent the erroneous detection of the room inside temperature from being caused by raising the rotating speed of compressor 117 and raising the rotating speed of cold air ventilation fan 116 due to displacement of the detection and necessity of an unnecessary cooling capacity from being caused.

[0135] Further, first discharge port 432 of upper stage freezing room 103 is installed so as to head for a front face direction in such a manner that the cold air flows within the room inside along the surface detected by the infrared sensor, and downward discharge port 435 adjusted such that the cold air flows downward is open to a lower side of first discharge port 432. Accordingly, since it is possible to lower the temperature difference between the detecting portion of infrared sensor 128 and the thermistor (not shown), and it is hard to be affected by the other peripheral temperature than food 121 within the detecting range, it is possible to precisely detect the temperature of the food. Since the temperature detected by infrared sensor 128 is converted into the temperature by detecting the amount of infrared ray within the detecting surface in addition to food 121, the temperature of the other portions than food 121 is detected if the temperature difference from the thermistor exists. In the present embodiment, since it is possible to lighten the temperature difference between the temperature of the other detecting surface than food 121 and the thermistor, it is possible to precisely detect the amount of the infrared ray of food 121, and it is possible to precisely detect the temperature of food 121. Further, since the present embodiment is structured such that the discharge cold air flows on the surface of cooling room cover 122, it is possible to promote a sublimation of a frost attached to the surface of cooling room cover 122 caused by an inflow of the ambient air having a high humidity by opening and closing the door, by the cold air which is generated and dehumidified by cooler 107 and has a low humidity, in addition to an improvement of the detecting precision of infrared sensor 128.

[0136] Further, conventionally, an erroneous detection has been sometimes prevented by comprehending a condition at a time of opening and closing the door by attaching a door switch so as to work with the switch, and employing such a specification that infrared sensor 128 does not detect in the case that the door switch starts, however, since the door switch and a control mechanism going with it are additionally necessary in this structure, a possibility of a trouble is more enhanced, and a cost increase is caused under a parts inflation based on a worldwide lack of a raw material, thereby causing a cost increase in an actual sales.

[0137] However, in the present embodiment, for example, when the door is closed and food 121 is contained, it detects the temperature of the food which is higher than the peripheral temperature, and detects the lower temperature zone than the storage room in which the infrared sensor is provided or the frozen temperature corresponding to the same temperature zone in a state in which the door is opened. Accordingly, for example, even in the case that the temperature temporarily rises going with the opening of the door, since a rapid temperature reduction can be detected thereafter in the case that a hot food is not actually put in, it is possible to determine that the rapid refrigeration is started automatically only in the case that a temperature gradient in a fixed time is calculated and is equal to or more than a set threshold value. Accordingly, it is possible to detect whether or not the temperature rise is caused by a disturbance, only by setting a control specification by a simple structure without attaching a door switch. Therefore, as mentioned above, there is obtained such an effect that it is possible to achieve a higher reliability and a resource saving of the material and prevent an attaching error at a time of assembling the parts.

[0138] In this case, under a humid climate condition which is peculiar to Japan, there is a case that a moisture dew condenses on a surface of infrared sensor 128 going with an inflow into the room of a warm moisture of the ambient air in the case of opening the door, however, if a dew condensation water is attached to the surface of infrared sensor 128 as mentioned above, the thermopile detects a temperature of the dew condensation water. Further, since the dew condensation water is frozen if the door is closed and the cooling operation of the room inside is started, the thermopile is hard to detect the temperature of the food until the frozen water drop sublimes. Accordingly, in the case of designing an arrangement of infrared sensor 128, an effect of preventing the dew condensation can be obtained by taking into consideration such a design that the infrared sensor is arranged in the thermally insulated partition portion defining the storage room having the higher temperature than the temperature of the adjacent storage room. In the structure of the present embodiment, it is preferable to install it in the refrigerating room side. Further, it is more preferable to arrange close to the door side corresponding to the highest temperature portion in the temperature distribution of the thermally insulated partition portion. A shutter mechanism may be mounted so as to correspond to the dew condensation prevention such as the prior art, however, since a complicated mechanism is necessary for working with the door open and close, a possibility of a trouble is increased and it is hard to mount to an actual refrigerator.

[0139] In addition, since it is possible to obtain such a design that the water content causing an aged deterioration is hard to be attached, by installing infrared sensor 128 to the portion in which the temperature is higher on the average than the peripheral temperature with respect to the storage room inside, an effect for elongating a product service life can be obtained.

[0140] Further, the present embodiment takes into consideration such a matter that the surface of the sensor probe is arranged below the surface of the thermally insulated partition portion at a time of installing infrared sensor 128 within the storage room. Accordingly, in addition that the temperature fluctuation of the detection is reduced by preventing the cold air from first discharge port 432 in the back face from excessively cooling the leading end portion of the probe, it serves to suppress the part lack or disconnection due to an excessive force application generated by a catch of the food and an attachment of a foreign material in the case of storing the foods over the storage amount, and a catch on a finger or a towel or the like corresponding to a cleaning material of the leading end of infrared sensor 128 at a time of cleaning.

[0141] It is preferable that a cover member which does not extend into the detection range as much as possible is provided in the storage room side of infrared sensor 128. In this case, it is desirable to prevent a warm air from staying within the cover member and prevent the finger of the user from coming into contact with the surface of infrared sensor 128.

[0142] Further, since infrared sensor 128 erroneously detects if thermistor 131 detecting its own temperature generates an excessive temperature fluctuation, it is desirable to set it apart from a portion having a thermal fluctuation at such a level that is not affected by the temperature. Since a pipe mainly made of a metal material such as a copper or steel is arranged in the refrigerator for radiating heat and preventing the surface dew condensation, a distance from the pipe is set apart at 15 mm or more in the present invention.

[0143] In order to correspond to the prevention of the dew condensation and the freezing in the leading end portion of infrared sensor 128, there is a method of utilizing a heater heat. In this case, it is possible to correspond at a low cost by employing a method of attaching a chip resistor on the substrate. As a capacity of the chip resistor, in infrared sensor 128 according to the present embodiment, it is possible to sufficiently secure a temperature rise in the leading end of the probe according to a duty factor of about 20 minutes per day by an electric voltage 5 V with a capacity about 0.25 W. Further, in the refrigerator used for a long period, a method of periodically refreshing by securely removing the dew condensation and the freezing by a frequency of one per one month to say nothing of everyday is effective for elongating the product service life.

[0144] As the cooling medium of the refrigeration cycle in recent years, there is used an isobutene corresponding to the combustible cooling medium having a small global warming factor in the light of global environment maintenance. The isobutene corresponding to a carbon hydride has a specific gravity (2.04 under 300 K) which is about twice under a room temperature and an atmospheric pressure in comparison with the air. If the isobutene corresponding to the combustible cooling medium leaks from the refrigeration system at a time when compressor 117 stops, it is heavier than the air, and leaks downward. Particularly, in the case of leaking from cooler 107 in which a holdup volume of the cooling medium is great, there is a possibility that an amount of leakage is increased, and it particularly tends to leak to the storage room communicating in the front side of cooler 107. However, since upper stage freezing room 103 arranging infrared sensor 128 is installed above cooler 107, it does not leak into upper stage freezing room 103 even if it leaks. Further, even if it leaks into upper stage freezing room 103, the cooling medium is heavier than the air, and stays in a lower portion of the storage room. Accordingly, since infrared sensor 128 is installed to the top surface of the storage room, a possibility that a portion in the vicinity of infrared sensor 128 comes to a combustible concentration is extremely low, and a sufficiently safe arrangement structure can be obtained.

[0145] Further, in order to more precisely detect the temperature of food 121, it is possible to improve a precision by detecting an area of food 121 after the food is put in, and adjusting a detection viewing angle of infrared sensor 128 in correspondence to the area of food 121. If it is possible to adjust the viewing angle by setting a position having a different temperature from the periphery to a subject to be detected, particularly, after putting in food 121, it is possible to improve a detection precision having a high cost performance in comparison with the detection of the area of the food.

[0146] In this case, the present embodiment is structured such that first discharge port 432 of upper stage freezing room 103 is installed so as to head for the front face direction in such a manner that the cold air flows within the room along the surface detected by the infrared sensor, and downward discharge port 435 adjusted in such a manner that the cold air flows in a downward direction is open to the lower side of first discharge port 432, however, first discharge port 432 installed in such a manner as to head for the front face direction may be extended further forward so as to cool mainly the front side of upper stage freezing room 103, and downward discharge port 435 may be arranged so as to cool mainly the rear side. In this case, it is possible to more uniformly cool the inner side of upper stage freezing room 103. Further, in the case that the discharge port is set at one position without setting first discharge port 432 and downward discharge port 435 at two positions, the cold air tends to flow more to the food mounting surface by arranging first discharge port 432 so as to head for slightly downward rather than the front face, and it is possible to make the temperature within the detection range of infrared sensor 128 lower. Accordingly, it is possible to make the detection precision in the case that a new food is put in higher.

(Embodiment 5)

[0147] In the present embodiment, a detailed description will be omitted with regard to the portion to which the same structure and the same technical concept as Embodiments 1 to 4 can be applied. With regard to the structure to which the same technical concept as the content described in Embodiments 1 to 4 can be applied, it is possible to achieve a structure obtained by combining with the technical content and the structure described in Embodiments 1 to 4.

[0148] FIG. 7 is a partially expanded side section view of a refrigerator according to Embodiment 5 of the present invention. In FIG. 7, since the temperature of lower stage freezing room 105 is detected at a time of opening the door, by doing away with the thermally insulated partition portion in a lower side of a surface of food 121 detected by infrared sensor 128 corresponding to a non-contact sensor, there is obtained such an effect that can further suppress the temperature fluctuation of the detection temperature. In other words, there are provided upper stage freezing room 103 corresponding to the storage room in which infrared sensor 128 is installed, and lower stage freezing room 105 corresponding to the adjacent storage room which is adjacent on a projection line of a detecting direction of infrared sensor 128 starting from infrared sensor 128 corresponding to the non-contact sensor of upper stage freezing room 103, upper stage freezing room 103 and lower stage freezing room 105 are set to the same temperature zone, and the same temperature zone cold air is fed by having discharge duct 434 in common. Accordingly, the cold air of discharge duct 434 is fed to upper stage freezing room 103 through first discharge port 432, and the cold air of discharge duct 434 is fed to lower stage freezing room 105 through second discharge port 433.

[0149] Further, since first discharge port 432 and second discharge port 433 are the discharge port having the shortest distance from cooler 107 and the discharge port having the second shortest distance, the cold air which just gets out of cooler 107 has a small thermal loss, thereby coming to the lowest temperature is discharged from first discharge port 432 and second discharge port 433. Therefore, the cold air is discharged at a higher cooling efficiency and having approximately the same temperature in first discharge port 432 and second discharge port 433.

[0150] Further, the cold air is fed at the same timing in first discharge port 432 and second discharge port 433.

[0151] In accordance with the structure mentioned above, since upper stage freezing room 103 corresponding to the storage room in which infrared sensor 128 is installed, and lower stage freezing room 105 corresponding to the adjacent storage room come to approximately the same temperature, the thermally insulated partition portion coming to the detection portion of the non-contact sensor comes to the same temperature as that of the portion detected at a time when the door is closed, even in the case that the door is opened, so that it is possible to suppress an erroneous detection whether or not the food is put in going with the door open and close.

[0152] For example, in the case that a temperature adjustment to a predetermined temperature of the storage room and the adjacent storage room is carried out by controlling the discharge amount of the discharged cold air, the predetermined temperature is maintained by the average temperature of the upper limit temperature and the lower limit temperature in no small way. Accordingly, in the case of adjusting the temperature of both the storage room and the adjacent storage room by the discharge cold air having the same temperature such as the present invention, the upper limit temperature and the lower limit temperature of the storage room are hard to be differentiated from those of the adjacent storage room. Therefore, since the upper limit temperatures and the lower limit temperatures going with the temperature adjustment come to approximately the same temperature between the storage room and the adjacent storage room, and it is possible to further suppress the erroneous detection of the non-contact sensor.

[0153] Further, since food 121 in upper stage freezing room 103 can be cooled from the downward direction in addition to from the upward direction by the cold air cooling lower stage freezing room 105, it is possible to extremely improve a cooling speed in addition to the case that third thermally insulated partition portion 212 is provided. Since it has been known that food 121 is less broken its cell breakage if it passes through a maximum frozen crystal creating range at 0°C to -5°C for a short time at a time of freezing, a freshness keeping characteristic at a time of freezing is widely improved by cooling food 121 from above and below by setting the same temperature zone without having any thermally insulated partition portion between upper stage freezing room 103 and lower stage freezing room 105. Therefore, it is the to be a very effective structure for storing the food in the actual refrigerator.

(Embodiment 6)

[0154] In the present embodiment, a detailed description will be omitted with regard to the same portion as the structure and the technical concept as described in Embodiments 1 to 5. With regard to the structure to which the same technical concept as the content described in Embodiments 1 to 5 can be applied, it is possible to achieve a structure obtained by combining with the technical content and the structure described in Embodiments 1 to 5.

[0155] FIG. 8 is a partially expanded side section view of a refrigerator according to Embodiment 6 of the present invention. In FIG. 8, a part within discharge duct 434 is provided with a position having a larger cross sectional area than the other portions, and an inflow into the room is suppressed by staying a warm air at a time of defrosting.

[0156] Accordingly, it is possible to prevent a detection displacement caused by a dew condensation and a frost formation of a detection portion of infrared sensor 328, and it is possible to keep a storage state of food 321 by suppressing a room temperature rise. In this case, in the present embodiment, the room inside inflow of the warm air is further reduced by arranging the position having the large cross sectional area within discharge duct 434 above cooler 307, and arranging above discharge port 332 of upper stage freezing room 303. Since a defrosting efficiency within cooling room 323 is increased by suppressing the room inside inflow, it is possible to achieve a reduction of a defrosting time, and it is also possible to reduce an amount of electric power consumption. Further, since a cooling operation stop time within the room can be shortened, there is obtained an effect that it is possible to suppress a temperature rise of food 321.

(Embodiment 7)

[0157] In the present embodiment, a detailed description will be omitted with regard to the same portion as the structure and the technical concept as described in Embodiments 1 to 6. With regard to the structure to which the same technical concept as the content described in Embodiments 1 to 6 can be applied, it is possible to achieve a structure obtained by combining with the technical content and the structure described in Embodiments 1 to 6.

[0158] FIG. 1 previously described is also a front view of a refrigerator according to Embodiment 7 of the present invention. Further, FIG. 2 previously described is also a side section view of the refrigerator according to Embodiment 7 of the present invention. FIG. 9 is a partially expanded side section view of an upper stage freezing room of the refrigerator according to Embodiment 7 of the present invention.

[0159] As shown in FIGS. 1, 2 and 9, refrigerator main body 101 is a thermally insulated box body constructed by outer box 124 which is open forward and is made of metal (such as steel plate), inner box 125 which is made of a hard resin (such as ABS), and urethane heat insulating material 126 which is foamed and filled between outer box 124 and inner box 125, and is constructed by refrigerating room 102 provided at an upper part of the main body, upper stage freezing room 103 provided below the refrigerating room, ice making room 104 provided below refrigerating room 102 and in parallel with upper stage freezing room 103, vegetable room 106 provided at a lower part of the main body, and lower stage freezing room 105 provided between upper stage freezing room 103 and ice making room 104 installed in parallel with each other, and vegetable room 106. Front face portions of upper stage freezing room 103, ice making room 104, lower stage freezing room 105 and vegetable room 106 are openably closed by drawer type doors (not shown), and a front face of refrigerating room 102 is openably closed by a door (not shown), for example, of a double-hinged door.

[0160] Refrigerating room 102 is set normally between 1°C and 5°C for storing under freeze while setting an ice-free temperature to a lower limit.

[0161] It is often the case that vegetable room 106 is set between 2°C and 7°C which is a set temperature equal to or slightly higher than refrigerating room 102. If it is set to a low temperature, it is possible to maintain a freshness of a leaf vegetable for a long period. Upper stage freezing room 103 and lower stage freezing room 105 are normally set between -22 and -18°C for storing under freeze, however, in order to improve the frozen storage state, it may be set to the low temperature, for example, between -30 and -25°C.

[0162] Since cold room 102 and vegetable room 106 are set their insides to plus temperatures, they are called as a refrigeration temperature zone. Further, upper stage freezing room 103, lower stage freezing room 105 and ice making room 104 are set their insides to minus temperatures, and they are called as a frozen temperature zone.

[0163] A top surface portion of refrigerator main body 101 is provided with a stepped recess toward a back face direction of refrigerator main body 101 so as to form machine room 119, and is constructed by a first top surface portion and a second top surface portion. A cooling operation is carried out by sealing a refrigeration cycle obtained by sequentially connecting compressor 117 arranged in the stepped concave portion, a dryer (not shown) removing a water content, a condenser (not shown), a heat radiation pipe (not shown) for radiating heat, capillary tube 118, and cooler 107. It is often the case that a combustible cooling medium has been used in the cooling medium for an environmental protection, in recent years. In this case, in the case of the refrigeration cycle using a three way valve and a switch valve, these functional parts can be arranged within the machine room.

[0164] Further, refrigerating room 102, ice making room 104 and upper stage freezing room 103 are defined by first thermally insulated partition portion 110.

[0165] Further, ice making room 104 and upper stage freezing room 103 are defined by second thermally insulated partition portion 111.

[0166] Further, ice making room 104, upper stage freezing room 103 and lower stage freezing room 105 are defined by third thermally insulated partition portion 112.

[0167] Since second thermally insulated partition portion 111 and third thermally insulated partition portion 112 are parts which are assembled after foaming refrigerator main body 101, a foamed polystyrene is used normally as the thermally insulated material, however, a rigid urethane foam may be used for improving a heat insulating performance and a rigidity, and a further thinness of a compartment structure may be achieved by inserting a vacuum insulating material having a high heat insulating property.

[0168] Further, a cooling wind path can be secured and an improvement of a cooling capacity can be achieved, by securing an operation portion of a door frame so as to thin or abolish the shapes of second thermally insulated partition portion 111 and third thermally insulated partition portion 112. Further, a reduction of a material is achieved by hollowing out center portions of second thermally insulated partition portion 111 and third thermally insulated partition portion 112 so as to form a wind path.

[0169] Further, lower stage freezing room 105 and vegetable room 106 are defined by fourth thermally insulated partition portion 113.

[0170] Cooling room 123 covered with cooling room cover 122 is provided in a back face of refrigerator main body 101. Within cooling room 123, fin and tube type cold air creating cooler 107 is arranged as a representative example in a back face of lower stage freezing room 105 including a rearward region of second and third thermally insulated partition portions 111 and 112 corresponding to thermally insulated room wall so as to be longer than is wide in a vertical direction. Further, a material of cooler 107 employs aluminum or a copper.

[0171] Cold air ventilation fan 116 ventilating the cold air created by cooler 107 to each of storage rooms including refrigerating room 102, ice making room 104, upper stage freezing room 103, lower stage freezing room 105 and vegetable room 106 based on a forced convection method is arranged in the vicinity (for example, an upper space) of cooler 107, and radiant heater 134 made of a glass tube and serving as a defrosting device removing a frost attached to cooler 107 and cold air ventilation fan 116 at a time of cooling is provided in a lower space of cooler 107. The defrosting device is not particularly designated, but a pipe heater closely attached to cooler 107 may be used in addition to radiant heater 134.

[0172] Within cooling room cover 122, there is provided a duct ventilating the cold air from cold air ventilation fan 116 to each of the storage rooms, and it directly ventilate the cold air in cooler 107 to upper stage freezing room 103 and lower stage freezing room 105 through the duct.

[0173] Cold air ventilation fan 116 may be directly arranged in inner box 125, however, it is possible to achieve a reduction of a manufacturing cost by arranging it in second thermally insulated partition portion 111 which is assembled after being foamed, and carrying out a block work of the parts.

[0174] Next, a description will be given of a structure of upper stage freezing room 103 to which infrared sensor 128 is attached.

[0175] As shown in FIG. 9, infrared sensor 128 corresponding to a non-contact sensor detecting a temperature of food 121 is installed in first thermally insulated partition portion 110 corresponding to a ceiling surface of upper stage freezing room 103 toward a direction (a downward direction in the present embodiment) in which an adjacent storage room on a plane of projection of the food mounting portion corresponding to the detecting surface exists. As mentioned above, infrared sensor 128 is provided in the storage room wall surface close to the opposed side to the food mounting portion, and since the food mounting portion is provided with cool storage medium 142 having a heat storage function, the food mounting portion has a heat storage function. Further, a back face upper portion of upper stage freezing room 103 is provided with first discharge port 132 discharging the cold air to an inside room from cooling room cover 122, and a return port (not shown) for the cold air circulating within upper stage freezing room 103 again returning to cooling room 123. In this case, since it is possible to make infrared sensor 128 hard to be affected by the wind of the cold air discharged from first discharge port 132, by installing infrared sensor 128 within the thermally insulated partition portion, it is possible to achieve an improvement of a detection precision. Further, since any foreign material is not attached to a detection portion of infrared sensor 128 in the case that a large amount of foods 121 are entered into the storage room or even at a cleaning time, by setting a leading end portion of infrared sensor 128 inside the surface of the thermally insulated partition portion, an erroneous motion of the detection is not caused. Further, since there is no catch at a time of cleaning caused by a protrusion to the room inside, it is possible to prevent a lacking of part and a displacement in a detecting direction due to an application of an excessive force. Further, since no protrusion is provided within the room, a room inside capacity is not reduced and there is an advantage that the capacity can be secured.

[0176] In this case, if mark 137 indicating a field of view is provided in the food mounting portion of case 127 within the storage room detected by infrared sensor 128, a storage site of food 121 is easy to be known for a customer, and it is possible to securely detect the temperature at a time of storing food 121, by additionally setting mark 137 in a smaller range than the field of view detected by infrared sensor 128. Particularly, since infrared sensor 128 is structured such that a detection intensity of the infrared ray becomes strongest in a center portion of the detecting range and becomes weaker toward an end of the detection range, it is preferable to put mark 137 based on the center for enhancing the detection precision. In the present embodiment, since the food mounting portion is formed by cool storage medium 142, mark 137 is attached to an upper surface side of cool storage medium 142.

[0177] Next, a description will be given of infrared sensor 128 which is used in the present embodiment.

[0178] Infrared sensor 128 detects an amount of the infrared ray emitted from the range of the detecting surface by a thermopile in a leading end thereof so as to convert into an electric signal. A probe is provided in the periphery of the thermopile, and a temperature detection is carried out by calculating a temperature of the detected subject by comparing with an electric voltage of the thermistor (not shown) corresponding to a reference temperature arranged in a substrate portion. Infrared sensor 128 is structured such that an infrared ray detection intensity is strongest in a center and the detection intensity becomes weaker toward an end, in a circle inner portion of the detecting range. Accordingly, it is possible to increase the intensity of the amount of infrared ray of the detected subject by narrowing a viewing angle of the thermopile, and it is possible to securely detect the temperature of the subject. However, since a part of the viewing angle laps over the leading end portion of the probe, it is affected by a temperature of the leading end portion so as to cause an erroneous detection. Therefore, according to the present embodiment, the viewing angle of the thermopile is set to 50°. Accordingly, mark 137 mentioned above can improve a precision of detection by mainly being attached to the center of the circle inner portion of the range detected by the infrared sensor.

[0179] Infrared sensor 128 used in the present embodiment employs the thermopile constructed by a lot of thermo couples formed on a silicon substrate. Further, a material of the probe portion is a molded product using alumina powder which is excellent in a thermal conductivity, however, any molded product obtained by dispersing a ceramic powder, for example, a magnesia powder, aluminum nitride powder or the like may be employed as far as the material which is excellent in the thermal conductivity. Further, if a resin type probe is used in a detection response of infrared sensor 128, a delay is generated in a response, however, since a specific gravity can be reduced, it is effective for a weight saving. It is possible to achieve a slight improvement of the response by reducing a thickness in the resin type probe. Since it is possible to reduce a volume, it is possible to lower an environmental load by a material saving. Thinning is same applied to the metal material which is excellent in the thermal conductivity.

[0180] With regard to the refrigerator constructed as mentioned above, a description will be given below of a motion and an operation thereof.

[0181] In the case that the room inside temperature rises and a refrigerating room sensor (not shown) becomes a start temperature or more of compressor 117, for example, due to a heat intrusion from an ambient air or a door opening and closing in refrigerating room 102, compressor 117 is started and the cooling in the room is started. A high-temperature and high-pressure cooling medium discharged from compressor 117 is cooled and liquefied based on a heat exchange with the air outside outer box 124 and urethane heat insulating material 126 within the room, until finally reaching a dryer (not shown) arranged in machine room 119, particularly in a condenser (not shown) or a heat radiation pipe (not shown) installed in outer box 124.

[0182] Next, the liquefied cooling medium is depressurized by capillary tube 118, flows into cooler 107 and is heat exchanged with the room inside air in the periphery of cooler 107. The heat exchanged cold air is ventilated into the room by cold air ventilation fan 116 in the vicinity thereof so as to cool the room inside. Thereafter, the cooling medium is heated and gasified so as to be turned back to compressor 117. In the case that the room inside is cooled and the temperature of the freezing room sensor (not shown) becomes equal to or less than the stop temperature, the operation of compressor 117 is stopped.

[0183] Further, since the door is closed at this time, infrared sensor 128 detects the temperature of case 127 within the upper stage freezing room from the thermopile attached to the top surface of upper stage freezing room 103 or the temperature of food 121. The refrigerator carries out a cooling operation by repeating the operation cycle mentioned above.

[0184] Next, a description will be given of a case that the load such as the food or the like is put in.

[0185] For example, in the case food 121 is put in upper stage freezing room 103 so as to be rapidly frozen, for example, in the case of buying a fresh food such as meat, fish or the like in a supermarket or the like, and in the case of cooking food 121 such as a hamburger or the like in the home so as to keep in a freezer, food 121 has been rapidly frozen conventionally by manually turning on a rapid freezing control. However, there is listed up a point of a bad usability that a work load of the user is increased by carrying out such a motion as to turn on the rapid freezing control manually after putting in food 121.

[0186] Further, there is a structure which can decide a time until the rapid freezing control is finished based on a set temperature of food 121, however, since it is optionally decided and a freezing speed is differentiated, for example, according to a magnitude and a thickness of food 121, there is a possibility that food 121 is not frozen even if the set temperature is detected, and it does not pass through the maximum frozen crystal creating range. Further, in the case that the set temperature is low, such a useless energy that the cooling operation is not finished and compressor 117 at a time of rapidly freezing is driven at a high speed in spite that food 121 is frozen may be used. Further, the temperature of food 121 is cooled under the influence of the peripheral temperature during the temperature set of the rapid freezing control end with respect to input food 121, and the thin food enters into the maximum frozen crystal creating range around turning on the rapid freezing control. Accordingly, there is a possibility that the suppression of the cell breakage is delayed and the fresh keeping characteristic is adversely affected.

[0187] Further, the prior art includes a structure in which the freezing is completed and the rapid freezing control is finished by detecting a change from a latent heat change of food 121 to a sensible heat change, however, there is a case that rates of the latent heat change and the sensible heat change are the same according to the magnitude and the thickness of food 121, for example, in a change rate of the sensible heat change. In the case that the magnitude of food 121 is large, the change rate in the sensible heat change becomes small, and in the case that the thickness of food 121 is small, the change rate in the sensible heat change becomes large. In other words, the change rate of the sensible heat change of food 121 is not constant, and in order to determine the frozen end based on the change rate, it is unavoidable to employ the change rate which is in conformity to the magnitude of larger food 121. Accordingly, in the case that the magnitude of food 121 is small, the cooling operation is carried out even if it is frozen, an additional cooling energy is used. Further, there is a case that the change rates of the latent heat change and the sensible heat change are not different even in the case that the operation state of cold air ventilation fan 116 and the cooling load state of the refrigerator are different by opening and closing a damper (not shown). For example, in the case of the prior art, a load amount in the case of cooling refrigerating room 102 and vegetable room 106 is different from a load amount in the case of cooling freezing room 108, ice making room 104 and switch room 109. In the case of cooling the load amount of refrigerating room 102 side, the temperature change rate of food 121 put in switch room 109 becomes small, and in the case of cooling the load amount in freezing room 108 side, the change rate becomes reversely large. Further, since the change rate becomes further smaller in the case of cooling both the rooms, it is necessary to extract an enormous amount of data and employ a complicated control specification for deriving the change rate in conformity to each of them, and this is not realistic.

[0188] Accordingly, the present invention is structured such as to detect an amount of the infrared ray emitted from the load such as the food into case 127 within the upper state freezing room detected by infrared sensor 128, turn on the rapid freezing control automatically in the case that that temperature calculated from the amount of the infrared ray is equal to or more than a fixed temperature (an upper limit set temperature: T0), and finish the rapid freezing control in the case that the temperature detected by infrared sensor 128 detects after setting the rapid freezing control is equal to or less than a fixed temperature (a lower limit set temperature: T1).

[0189] As a motion of the rapid freezing control, when food 121 is put in and the detection temperature of infrared sensor 128 detects T0 corresponding to a start temperature or higher, the refrigerator increases the amount of the circulating cooling medium by increasing the rotating speed of compressor 117, and descends the temperature of cooler 107. Further, it increases the rotating speed of cold air ventilation fan 116, whereby it rapidly cools food 121 by increasing the cooling amount circulating the cold air created by cooler 107 within the room. Thereafter, if it comes to the lower limit set temperature T1 corresponding to the finish temperature after confirming the passage of the temperature 0°C to -5°C corresponding to the maximum frozen crystal creating range during the continuous detection of the temperature of food 121, the maximum frozen crystal creating range affecting the freshness for storing the food is rapidly passed by automatically finishing the rapid freezing control and changing to the normal cooling operation. Since the deterioration of the freshness keeping characteristic is hardly affected even by normally cooling after passing through the maximum frozen crystal creating range, the normal operation is carried out. In the present embodiment, the start temperature of the rapid freezing control, that is, the upper limit temperature T0 is set to -2.5°C, and the end temperature of the rapid freezing control, that is, the lower limit temperature T1 is set to -15°C. This is because the state is differentiated by the food storage aspect or the food own aspect.

[0190] In accordance with the present embodiment, since the rapid freezing control is turned on automatically and an improvement of the cooling capacity is automatically achieved, it is possible to cool the refrigerator according to a cooling operation as occasion demands. Particularly, since it is possible to shorten an operating time as an amount of an electric power consumption of an actual refrigerator by employing a high-capacity and short-time cooling, rather than by operating compressor 117 at a middle rotation so as to slowly cool the load such as the conventional one, with respect to a rise of the room inside temperature based on the load input or a cooling of the load to be rapidly frozen, energy saving can be achieved. In the present embodiment, the cold air in first and second discharge ports 132 and 133 is lowered near to -40°C so as to rapidly freeze, by temporarily setting the rotating speed of compressor 117 to 80 Hz during the rapid freezing control, and setting the rotating speed of cold air ventilation fan 116 to about 3000 rotation per minute, however, a time is shortened for 30 minutes or more with respect to the conventional rapid freezing control, and an energy saving effect Δ23 % can be obtained per one time as an energy saving effect.

[0191] Further, in the present embodiment, since cool storage medium 142 is attached within the case of upper stage freezing room 103, a freezing effect caused by a direct thermal transmission from frozen cool storage medium 142, that is, a thermal conduction is applied, in addition to a freezing effect caused by the thermal transmission by the cold air at about -40°C created by cooler 107, a time passing through the maximum frozen crystal creating range is further quickened and a drip amount from food 121 at a time of defrosting the food is reduced. Accordingly, it is possible to further achieve an improvement of the food storage.

[0192] Particularly, since food 321 is cooled based on the cooling from cool storage medium 142, and case 127 is kept at a lower temperature than the case that cool storage medium 142 is not provided, it is possible to cool food 121 for a short time. Accordingly, it is possible to achieve a reduction of the cooling operation time of the refrigerator so as to achieve energy saving and it is possible to achieve an improvement of a freshness keeping characteristic of food 321.

[0193] Further, since cool storage medium 142 is arranged, cool storage medium 142 absorbs a thermal load of an ambient air inflow even in the case that food 121 is not put in or even in the case that the ambient air inflows at a time of opening and closing the door, it is possible to suppress the temperature rise within the room.

[0194] In other words, the effect of the present embodiment is as follows in the light of the energy saving and the food storage.

[0195] First of all, in the light of the energy saving, since the temperature of the food is detected by the sensor detecting in a non-contact manner so as to automatically start the rapid freezing control, and the operation gives way to the normal cooling motion rapidly at a time point when the temperature reaches the end temperature, the rapid cooling of the food put in the room is rapidly and automatically started. Further, since the food mounting portion has the heat storage function, the food mounting portion which has been cooled to the frozen temperature zone and has the heat storage function comes into contact with the food, whereby it is possible to directly absorb the heat based on the thermal conduction and rapidly cool, it is possible to widely shorten a continuous operating time of the compressor and the cold air ventilation fan even in the case that the rapid freezing control is carried out, and it is possible to carry out the rapid cooling in which the energy saving is further achieved.

[0196] Further, in the light of the food storage, in the present invention, since the food mounting portion at a time of carrying out the rapid freezing control has the heat storage function, whereby it is possible to rapidly cool by using both the thermal transmission caused by introducing the cold air carrying out the rapid freezing control, and the thermal conduction from the food mounting portion having the heat storage function, the passing time of the maximum frozen crystal creating range of 0°C to -5°C particularly affecting greatly the freshness in the frozen storage can be shortened. Since it is possible to suppress the drip amount from the food at a time of defrosting by passing through the maximum frozen crystal creating range for a short time, it is possible to store without deteriorating the freshness and a taste of the food. Accordingly, it is possible to enhance a storage quality of the food.

[0197] As mentioned above, in the present embodiment, since the rapid freezing control is turned on automatically, and the rapid freezing control is automatically cancelled at a time when the food is frozen, such a troublesome motion as to be manually applied to food 121 to be rapidly frozen such as the conventional one is not necessary, and it is possible to do away with a waste of an unnecessary energy caused by the unnecessary cooling operation after freezing, and it is possible to achieve a further energy saving since the food mounting portion is formed by cool storage medium 142.

[0198] Further, when the user comes back home from shopping and stores food 121 in the refrigerator for keeping a fresh food such as meat or the like in a freezer, the room inside temperature rises under the influence of the door open for a long time. In this case, since the rapid freezing control is not turned on automatically in conventional, food 121 is cooled for a long time by a low cooling capacity, however, in the present invention, since the rapid freezing control is turned on automatically if the temperature is high, based on the temperature detected by infrared sensor 128, it is possible to rapidly cool without too long time by a high cooling capacity. As a result, since it is possible to shorten the cooling time for cooling and it is possible to suppress the temperature rise of the food itself based on the cooling for a short time, it is possible to suppress the deterioration of the freshness keeping performance.

[0199] Further, since the cooling capacity is increased by raising the rotating speed or the electric voltage of cold air ventilation fan 116 for operating compressor 117 at a high rotation and increasing a wind amount feeding the cold air created by cooler 107 into the room during the rapid freezing control, a noise level has risen conventionally for a fixed time, however, in the present embodiment, since the rapid freezing control is carried out around 0°C to -5°C corresponding to the maximum frozen crystal creating range, it is possible to shorten the time 30 minutes or more with respect to the conventional rapid freezing control time.

[0200] In this case, in the present embodiment, the upper limit and lower limit temperatures are set as the set temperature of the rapid freezing control, however, it is possible to classify the food input and only the door open and close by setting an auxiliary detection period of a fixed time (for example, three minutes) after passing through the set temperature, and detecting a temperature behavior after putting in food 121. Particularly, parts such as a part detecting the door open and close, for example, a door switch, a harness and the like become expensive due to a worldwide material cost rising and a mineral lack in recent years, and there is fear that the control is complicated by adding the door switch. Accordingly, since it is not necessary to use the door switch mechanism by setting the auxiliary detecting period, a resource saving is achieved.

[0201] In this case, it is possible to clarify a simplicity caused by the automatic rapid freezing control, by turning on a lamp or the like indicating the rapid freezing control for showing to the user, for example, in the door portion of the front face, under the rapid freezing control.

[0202] In this case, the rotating speed of compressor 117 is temporarily increased around the temperature detecting period of the maximum frozen crystal creating range, under the rapid freezing control, however, it is possible to protect the pressure in the low pressure side of compressor 117 by deciding the upper limit of the rotating speed of compressor 117 by the ambient air temperature. In the present embodiment, the rotating speed is made lower than 80 Hz corresponding to the rotating speed of conventional compressor 117 in the case of a middle ambient air temperature and a low ambient air temperature, for example, the maximum rotating speed of compressor 117 is set to 69 Hz in the case that the ambient air temperature is 15°C.

[0203] Further, as the cooling medium of the refrigeration cycle in recent years, there is used an isobutene corresponding to the combustible cooling medium having a small global warming factor in the light of global environment maintenance. The isobutene corresponding to a carbon hydride has a specific gravity (2.04 under 300 K) which is about twice under a room temperature and an atmospheric pressure in comparison with the air. If the isobutene corresponding to the combustible cooling medium leaks from the refrigeration system at a time when compressor 117 stops, it is heavier than the air, and leaks downward. Particularly, in the case of leaking from cooler 107 in which a holdup volume of the cooling medium is great, there is a possibility that an amount of leakage is increased. However, since upper stage freezing room 103 arranging infrared sensor 128 is installed above cooler 107, it does not leak into upper stage freezing room 103 even if it leaks. Further, even if it leaks into upper stage freezing room 103, the cooling medium is heavier than the air, and stays in a lower portion of the storage room. Accordingly, since infrared sensor 128 is installed to the top surface of the storage room, a possibility that a portion in the vicinity of infrared sensor 128 comes to a combustible concentration is extremely low.

[0204] Further, in order to more precisely detect the temperature of food 121, it is possible to improve a precision by detecting an area of food 121 after the food is put in, and adjusting a detection viewing angle of infrared sensor 128 in correspondence to the area of food 121. If it is possible to adjust the viewing angle by setting a position having a different temperature from the periphery to a subject to be detected, particularly, after putting in food 121, it is possible to improve a detection precision having a high cost performance in comparison with the detection of the area of the food.

(Embodiment 8)

[0205] In the present embodiment, a detailed description will be omitted with regard to the same portions as the structure and the technical concept described in Embodiments 1 to 7. With regard to the structure to which the same technical concept as the content described in Embodiments 1 to 7 can be applied, it is possible to achieve a structure obtained by combining with the technical content and the structure described in Embodiments 1 to 7.

[0206] FIG. 10 is a partially expanded side section view of a refrigerator according to Embodiment 8 of the present invention. In FIG. 10, it is possible to cool the food mounting portion, that is, cool storage medium 242 from both upper and lower sides, by doing away with the surface detected by infrared sensor 228, that is, third thermally insulated partition portion 212 of the food mounting portion. Accordingly, since it is possible to cool food 221 put in upper stage freezing room 203 from the lower state by the cold air cooling lower stage freezing room 205, it is possible to extremely improve the cooling speed in addition to the case that third thermally insulated partition portion 212 is provided. Since it has been known that food 221 is less broken its cell breakage if it passes through a maximum frozen crystal creating range at 0°C to -5°C for a short time at a time of freezing, cooling food 221 from the upper and lower sides by doing away with third thermally insulated partition portion 212 is very effective for storing the food.

[0207] Further, in the present embodiment, since cool storage medium 242 is attached within the case of upper stage freezing room 203, a freezing effect caused by the direct thermal conduction from frozen cool storage medium 242, that is, the thermal conduction is applied, in addition to the refrigerating effect caused by the thermal transmission by the cold air at about -40°C created by cooler 207. Accordingly, a time passing through the maximum frozen crystal creating range is further quickened and a drip amount from food 221 at a time of defrosting the food is reduced. Therefore, it is possible to further achieve an improvement of the food storage.

[0208] Particularly, since food 221 is cooled based on the cooling from cool storage medium 242, and container 227 corresponding to the case is kept at a lower temperature than the case that cool storage medium 242 is not provided, it is possible to cool food 221 for a short time. Accordingly, it is possible to achieve a reduction of the cooling operation time of the refrigerator so as to achieve energy saving and it is possible to achieve an improvement of a freshness keeping characteristic of food 221.

[0209] Further, since cool storage medium 242 is arranged, cool storage medium 242 absorbs a thermal load of an ambient air inflow even in the case that food 221 is not put in or even in the case that the ambient air inflows at a time of opening and closing the door, it is possible to suppress the temperature rise within the room.

(Embodiment 9)

[0210] In the present embodiment, a detailed description will be omitted with regard to the same portions as the structure and the technical concept described in Embodiments 1 to 8. With regard to the structure to which the same technical concept as the content described in Embodiments 1 to 8 can be applied, it is possible to achieve a structure obtained by combining with the technical content and the structure described in Embodiments 1 to 8.

[0211] FIG. 11 is a side section view of a refrigerator according to Embodiment 9 of the present invention. In FIG. 11, the structure is made such as to cool a frozen temperature zone including upper stage freezing room 403 and lower stage freezing room 405, and a cold temperature zone including refrigerating room 402 and vegetable room 406 respectively by freezing cooler 414 and refrigerating cooler 415 having different evaporating temperatures. Accordingly, since food 421 put in case 427 in which cool storage medium 426 is stored in a bottom surface in upper stage freezing room 403 provided with infrared sensor 425 in a top surface can reduce a cooling load amount with respect to a refrigeration capacity of freezing cooler 414 in the refrigeration temperature zone, it is possible to lower the temperature generated in freezing cooler 414, and it is possible to lower a temperature of a discharger cold air from first and second discharge ports 432 and 433. Therefore, it is possible to raise a capacity for freezing food 421. Accordingly, since it is possible to shorten a freezing time of food 421, it is possible to achieve a reduction of an amount of electric power consumption.

INDUSTRIAL APPLICABILITY

[0212] As mentioned above, since the refrigerator according to the present invention is structured such as to set the temperature zone of the detecting surface and the temperature zone on the extension line the same temperature at a time of detecting the temperature of the food by using the infrared sensor, it is possible to reduce the detection error at a time of opening and closing the door.

[0213] Further, since the rapid freezing control is turned on automatically by detecting the temperature of the food put in the storage room in which the infrared sensor is installed, the improvement of the cooling capacity is automatically carried out around the time zone of the maximum frozen crystal creating range, and the rapid freezing control is automatically canceled, the cooling operation can be carried out in correspondence to the load amount of the refrigerator. Accordingly, it is possible to cool with ecology and at a high efficiency, and it is possible to apply to a general refrigeration equipment detecting the temperature of the food.

Claims

1. A refrigerator comprising:

    a thermally insulated box body which is constructed by a plurality of temperature zones partitioned by a plurality of thermally insulated compartments;
    a storage room which is defined such that the room is thermally insulated in the thermally insulated box body and in which a non-contact sensor for detecting a temperature of a food is installed; and
    an adjacent storage room which is adjacent to the storage room, on a projection line in a direction in which the non-contact sensor detects, the projection line starting from the non-contact sensor of the storage room, wherein the storage room in which the non-contact sensor is installed, and the adjacent storage room are set in the same temperature zone, or the adjacent storage room is set in a lower temperature zone than the storage room in which the non-contact sensor is installed.

2. The refrigerator according to claim 1, wherein
the non-contact sensor is an infrared sensor, and is installed in a portion having a relatively higher temperature in the storage room.

3. The refrigerator according to claim 2, further comprising a reserve room set in a higher temperature zone than the temperature zone of the adjacent storage room, wherein
the infrared sensor is installed in the vicinity of the reserve room.

4. The refrigerator according to claim 2 or 3, wherein
the infrared sensor is installed in a thermally insulated partition portion defining the storage room and the reserve room with thermal insulation.

5. The refrigerator according to claim 4, wherein
a leading end of the infrared sensor is installed in a surface of the thermally insulated partition portion or an inner side of the surface.

6. The refrigerator according to claim 2 or 3, wherein
the temperature zone of the storage room in which the infrared sensor is installed is set to a frozen temperature zone.

7. The refrigerator according to claim 2 or 3, wherein
a viewing angle at which the infrared sensor detects is equal to or less than 55°.

8. The refrigerator according to claim 2 or 3, wherein
a field of view of a surface detected by the infrared sensor is provided with a mark which is smaller than the field of view.

9. A refrigerator comprising:

a storage room in which a non-contact sensor for detecting a surface temperature of a food placed on a food mounting portion is installed;
cooling means for cooling the storage room; and
rapid freezing control means for cooling the storage room with a high cooling capacity, wherein
the food mounting portion has a heat storage function,
a rapid freezing control is automatically started by the rapid freezing control means for cooling with the high cooling capacity if the temperature detected by the non-contact sensor is higher than a previously set start temperature, and
the rapid freezing control by the rapid freezing control means is stopped at a time point at which the temperature reaches a previously set end temperature.

10. The refrigerator according to claim 9, wherein
the non-contact sensor is constructed by an infrared sensor, and is provided in a storage room wall surface in an opposite side to the food mounting portion, and the storage room is a freezing room which is settable only in a frozen temperature zone.

11. The refrigerator according to claim 10, wherein
the temperature zone in which the rapid freezing control is automatically started by the rapid freezing control means includes a detection temperature between 0°C and -5°C in the temperature detected by the infrared sensor.

FIG. 1

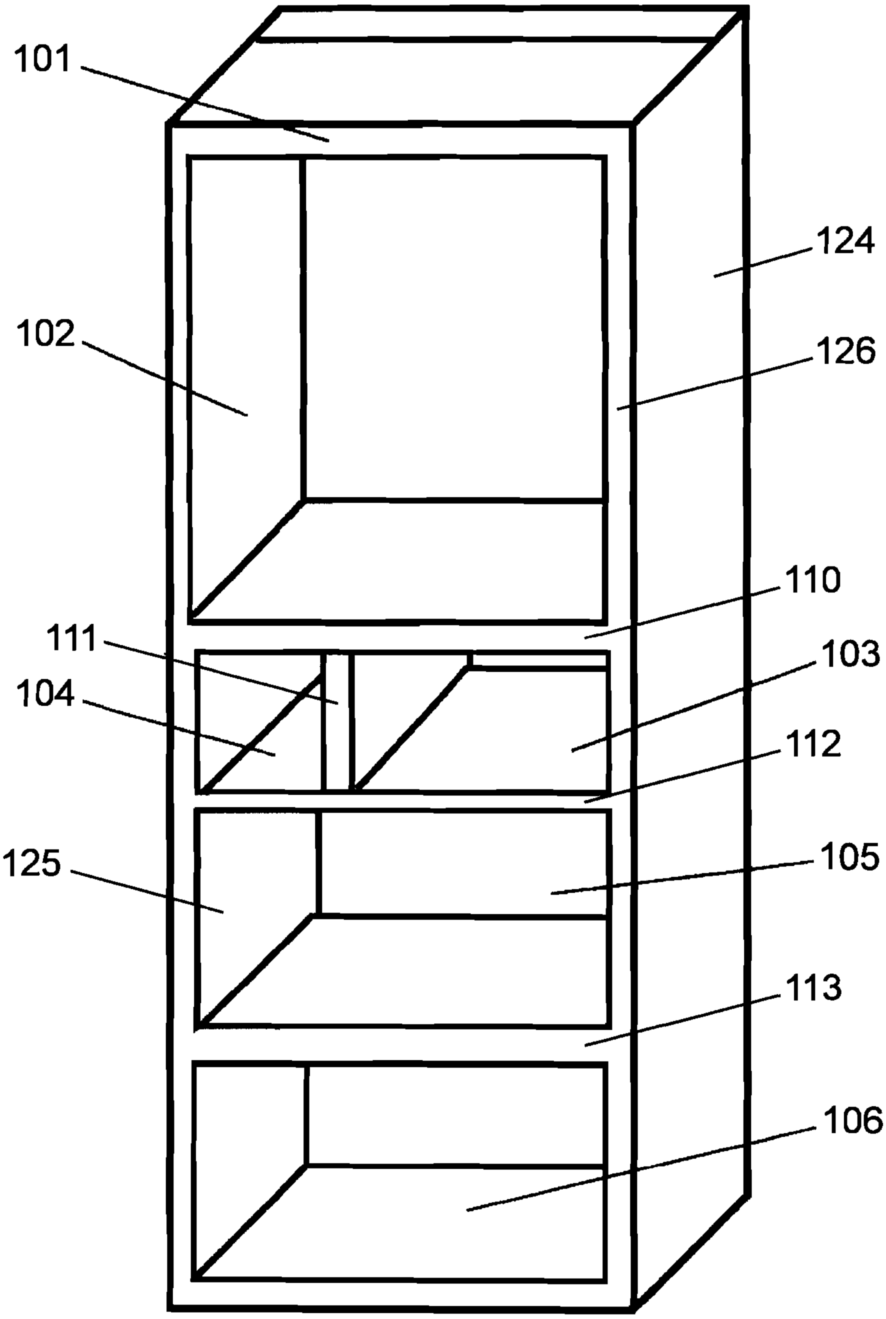
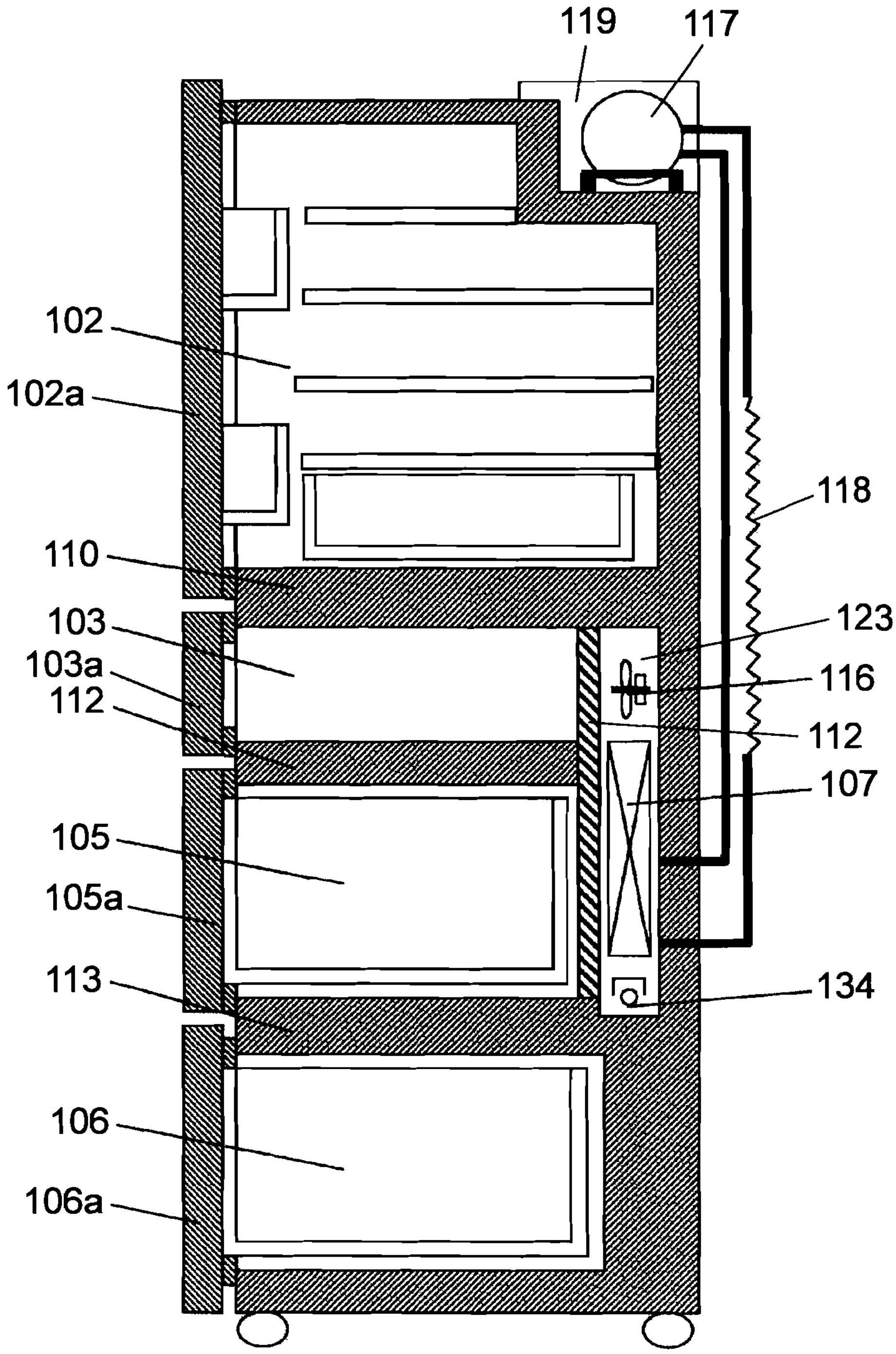


FIG. 2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106a

FIG. 3

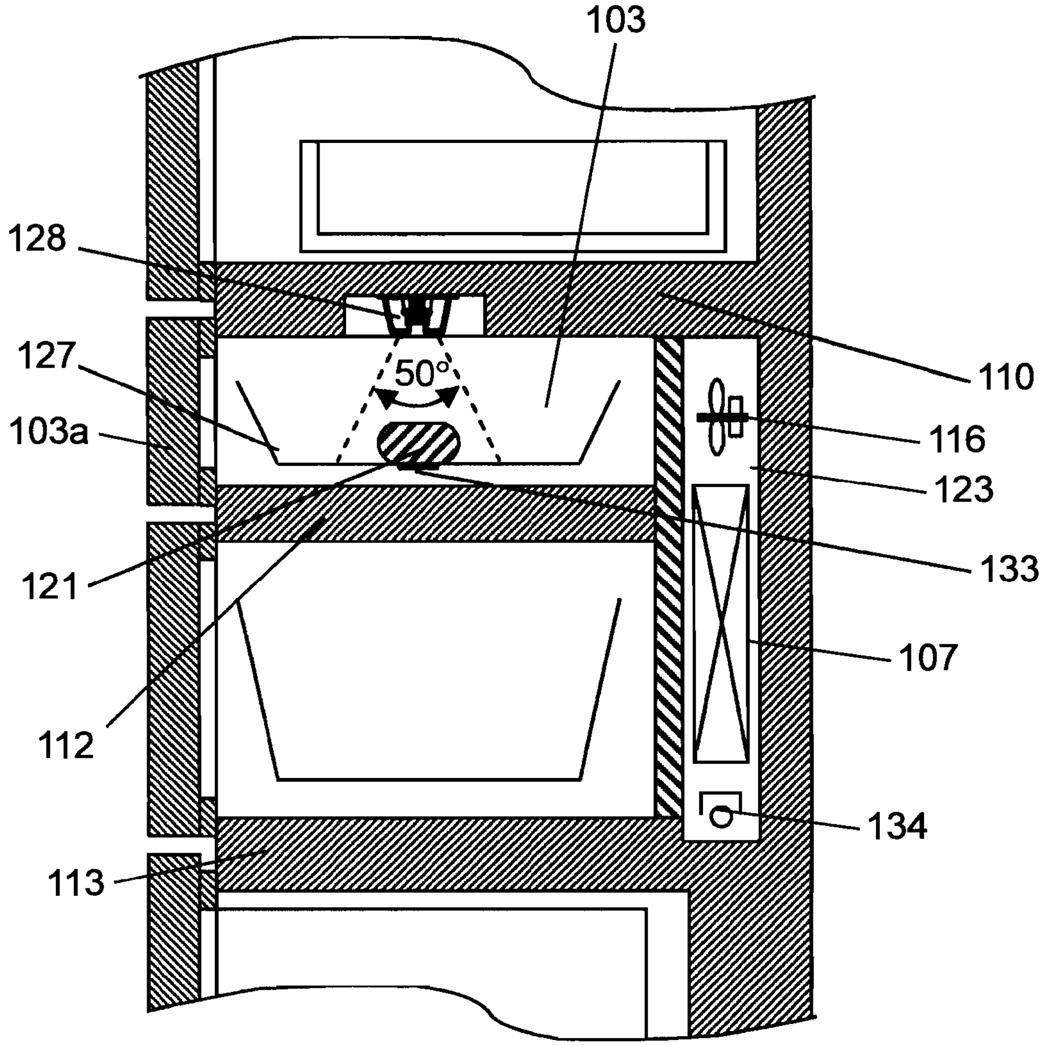


FIG. 4

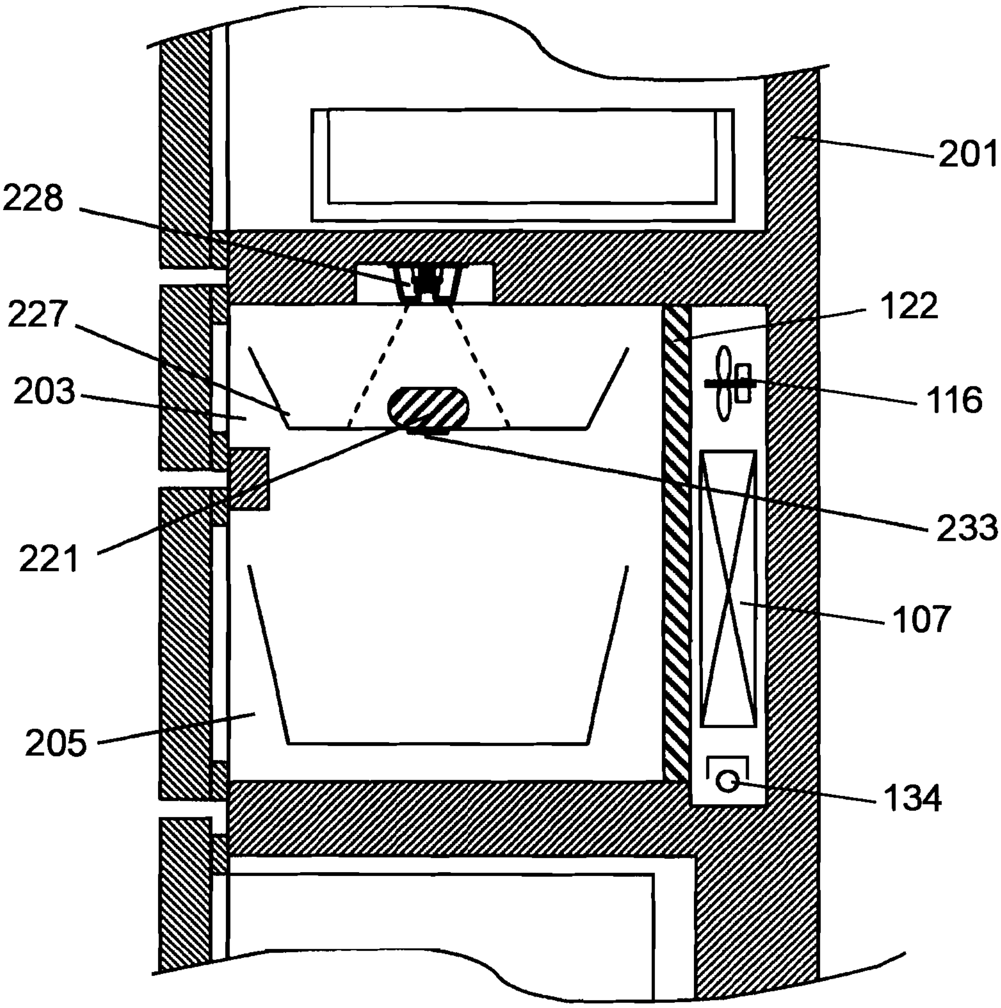


FIG. 5

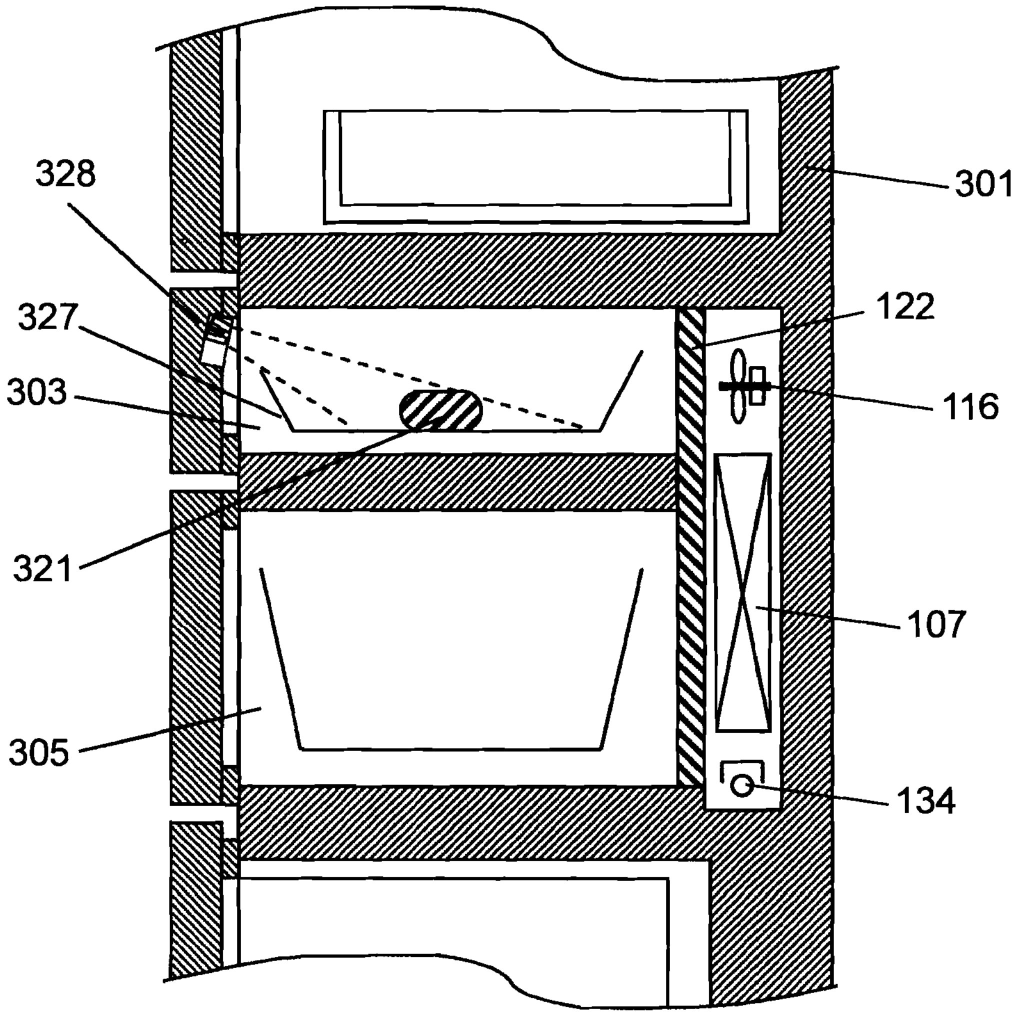
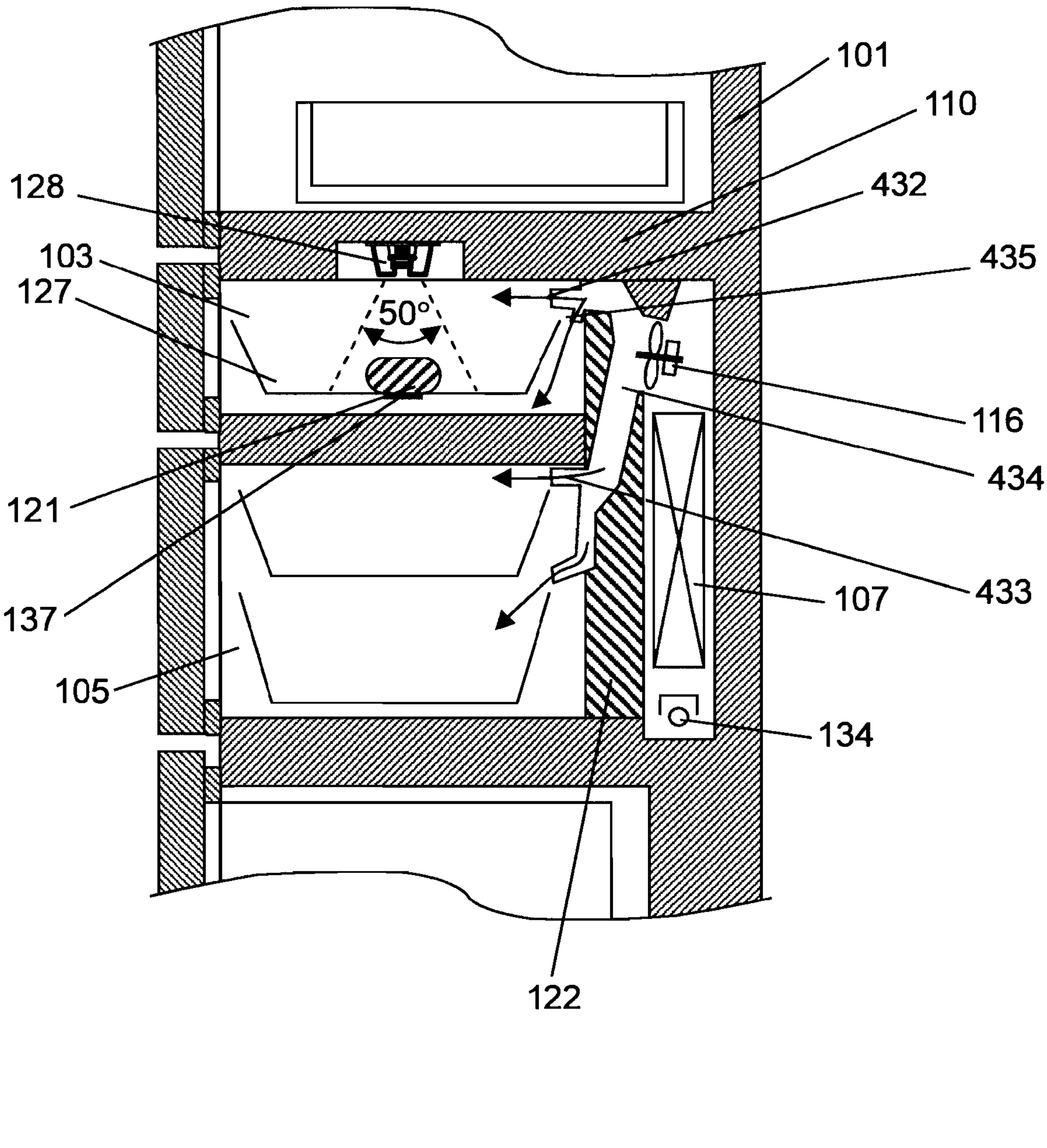


FIG. 6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103
435
127
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116
434
121
433
137
107
105
134
122

FIG. 7

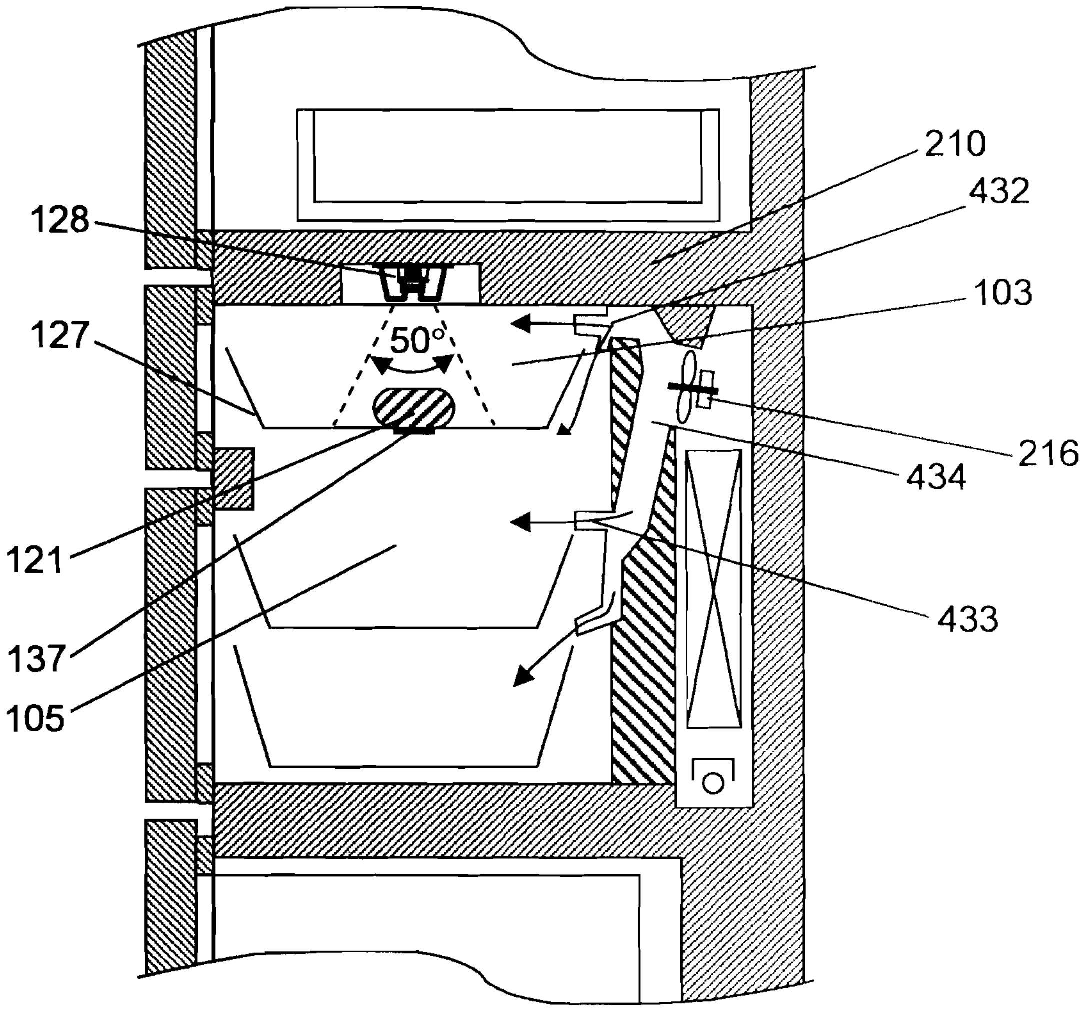


FIG. 8

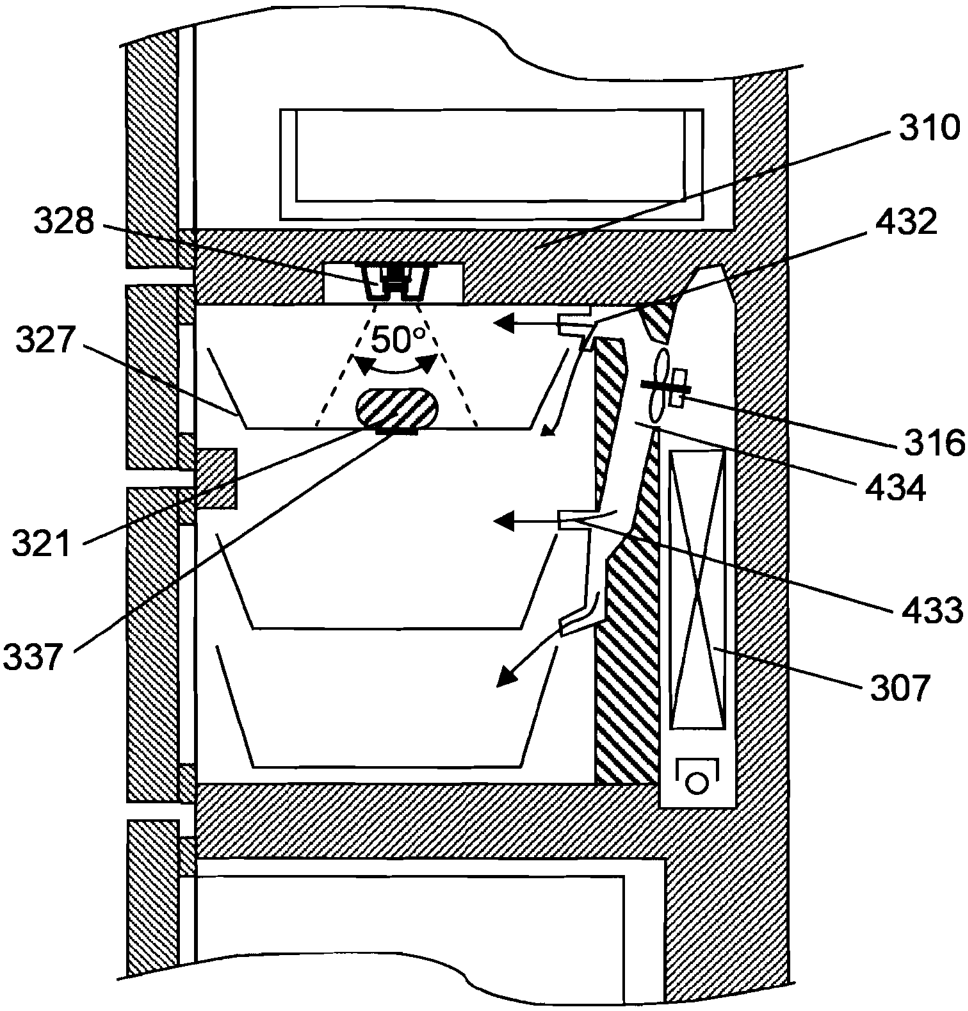


FIG. 9

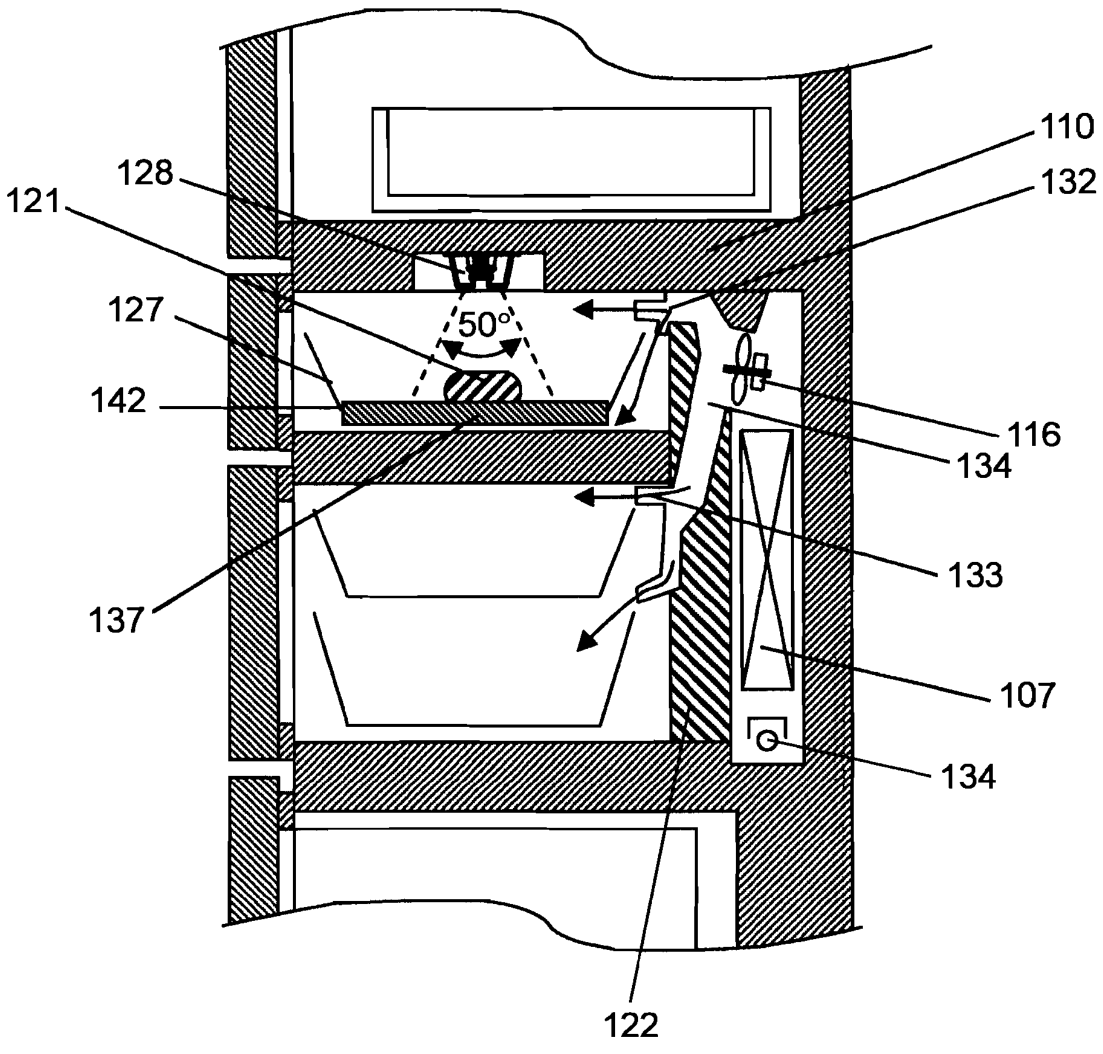


FIG. 10

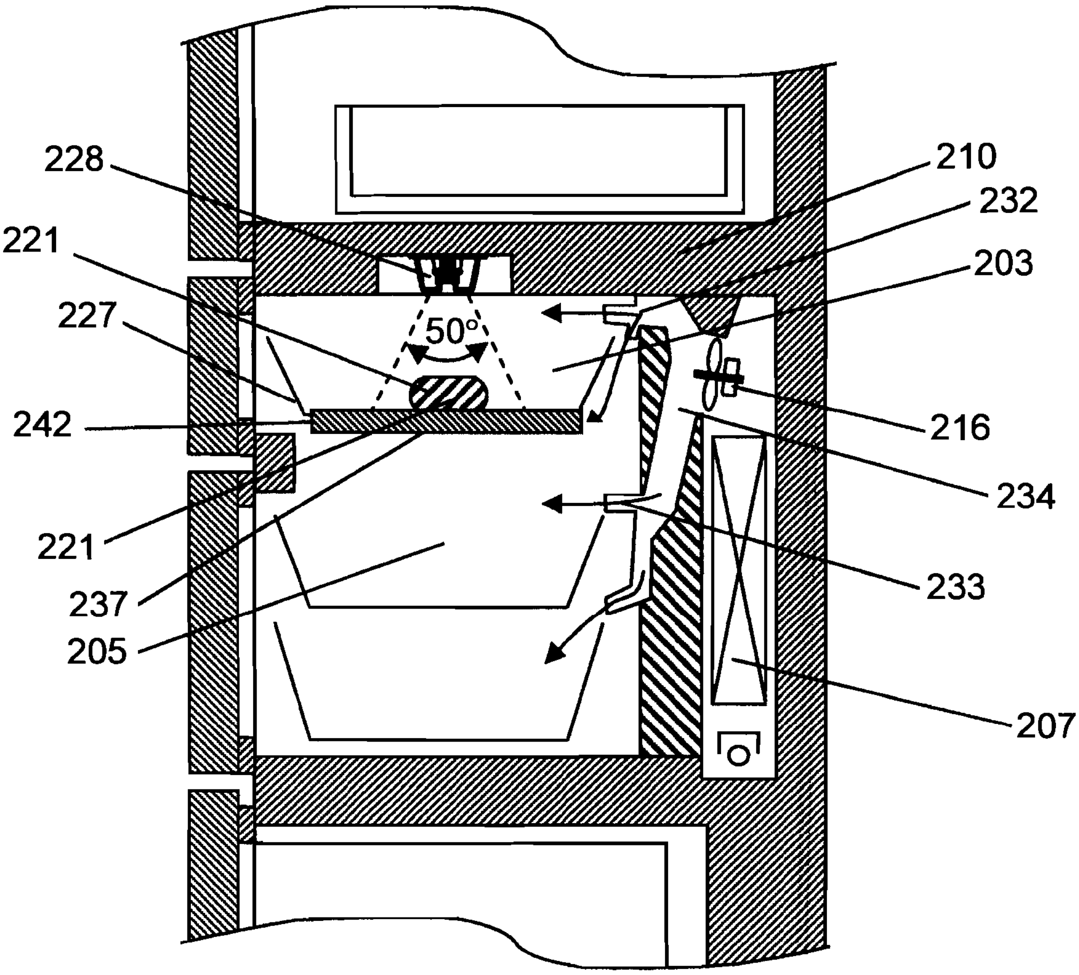


FIG. 11

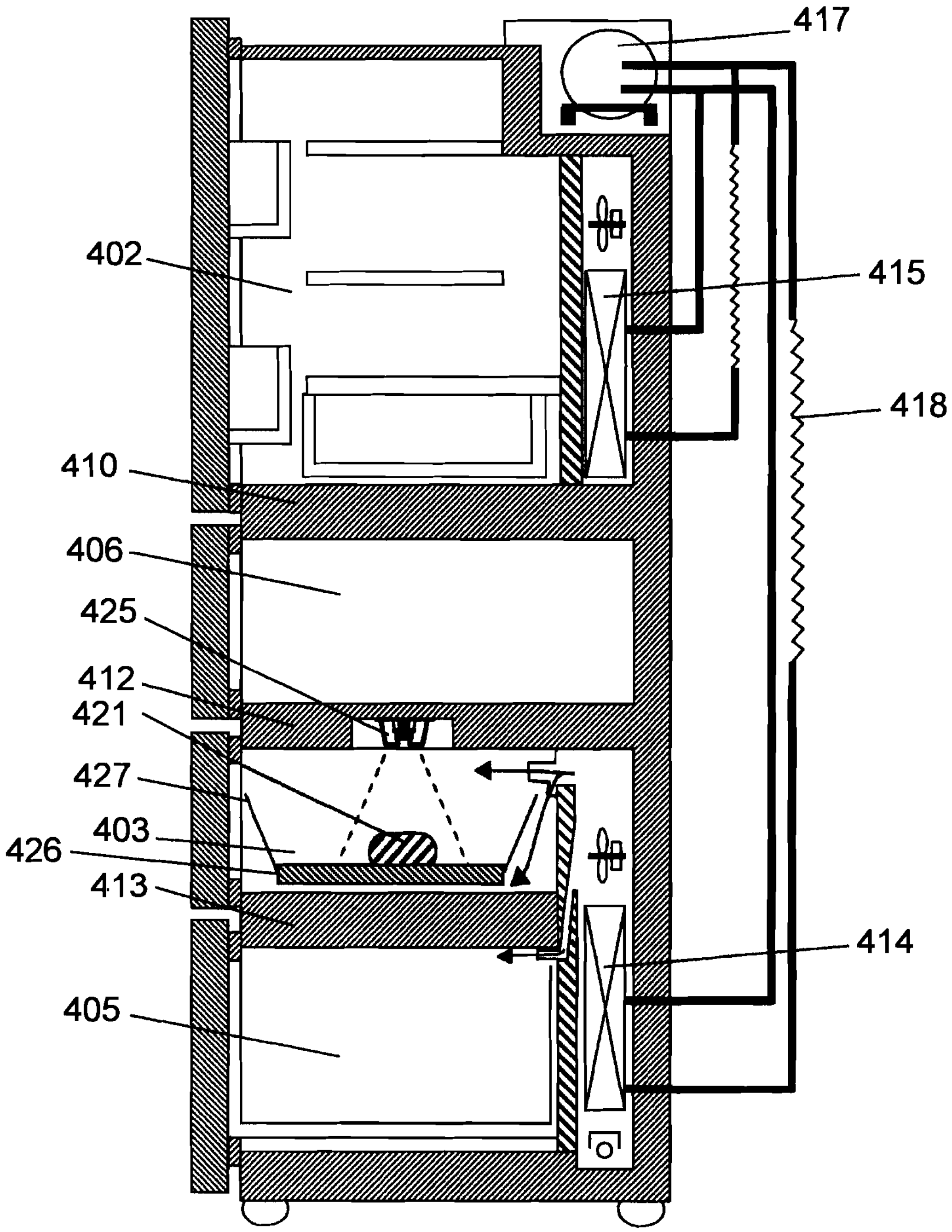


FIG. 12

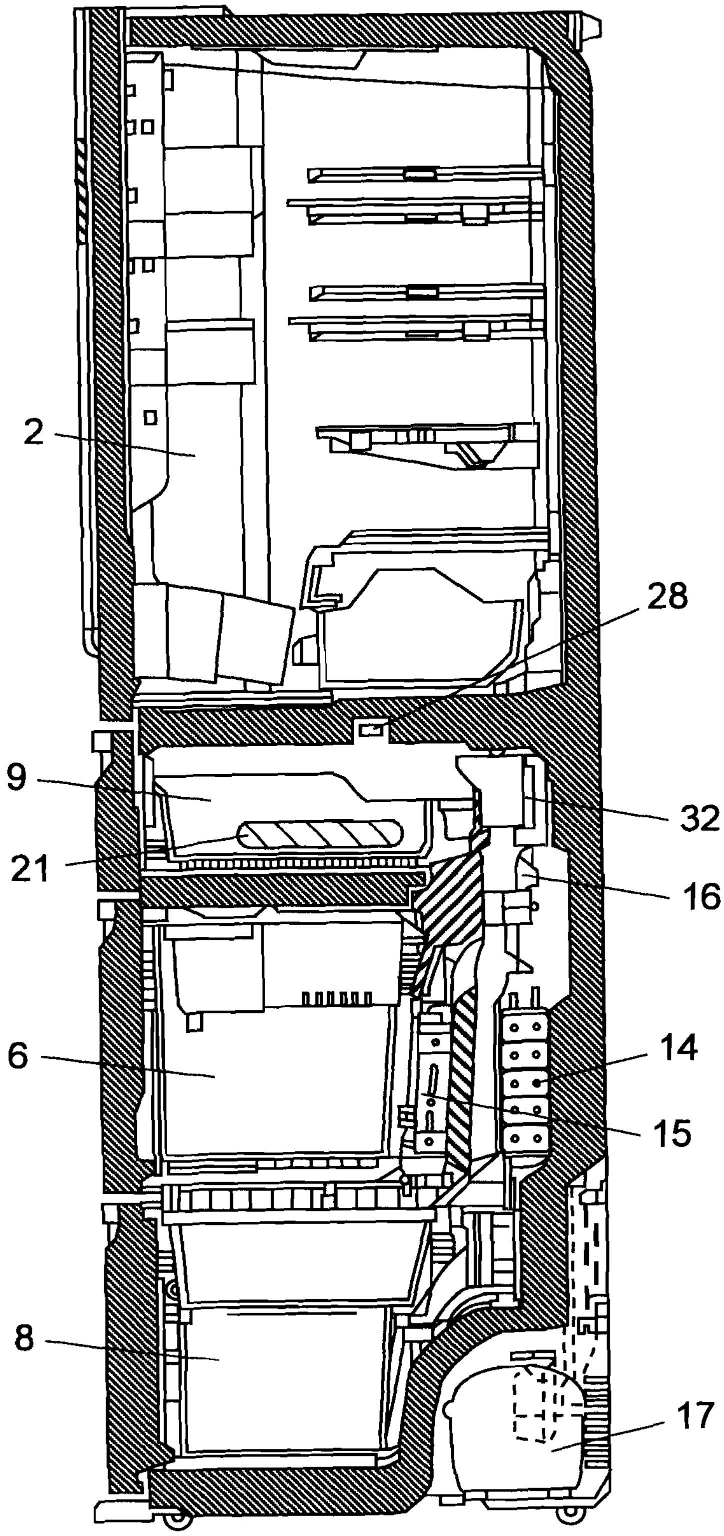


FIG. 13

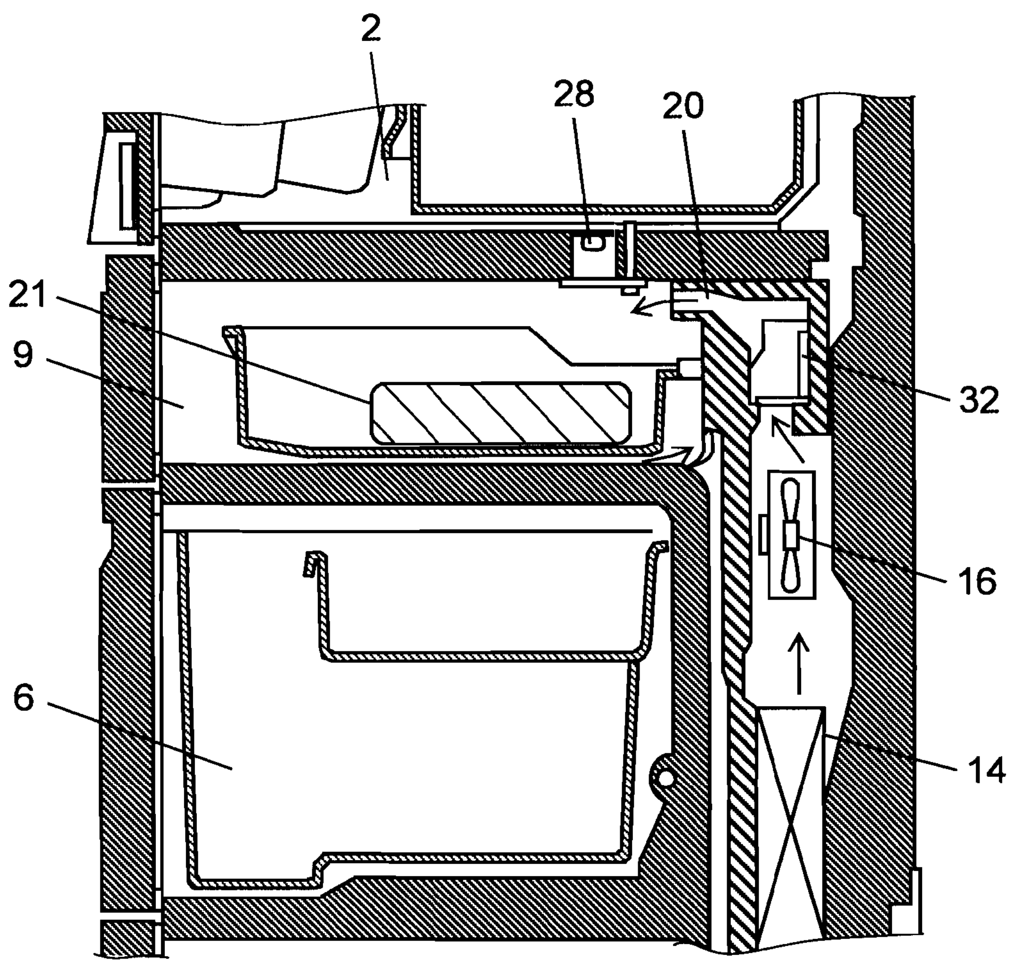


FIG. 14

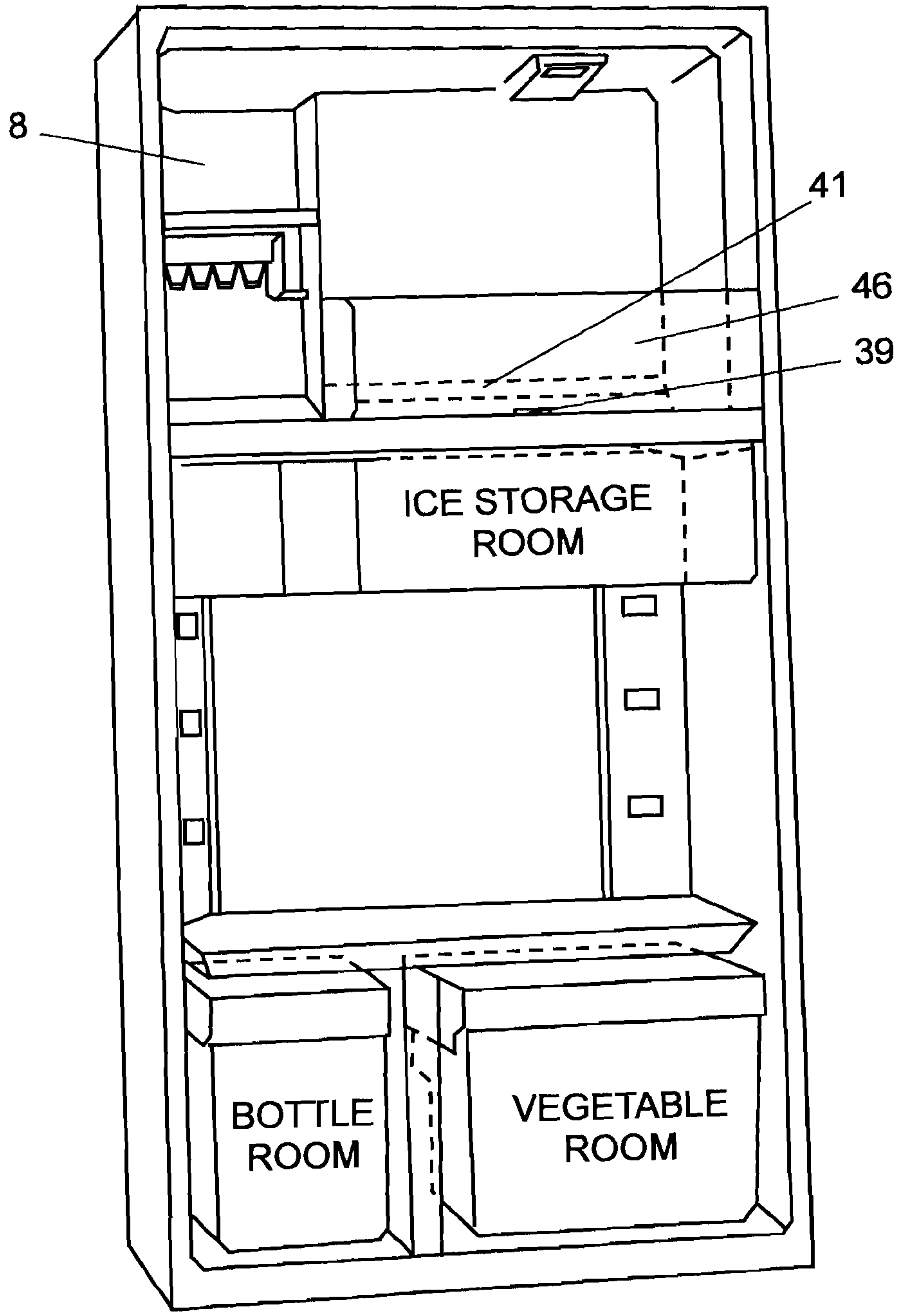
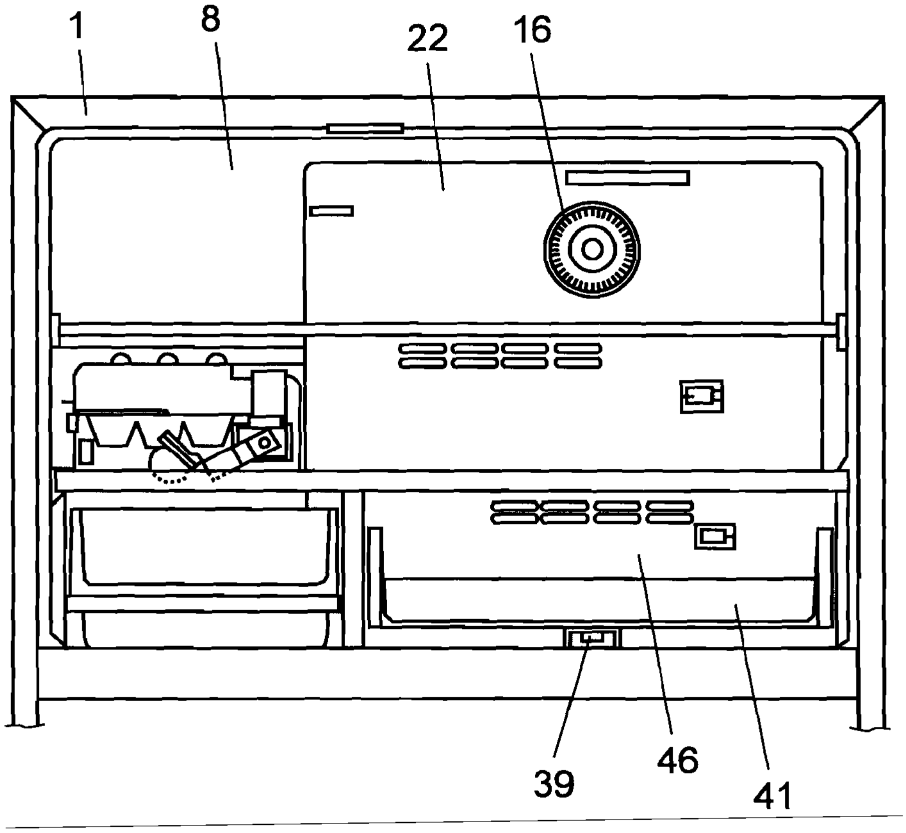


FIG. 15



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/001108

A. CLASSIFICATION OF SUBJECT MATTER
F25D29/00(2006.01)i, *F25D11/02*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F25D29/00, F25D11/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2009
Kokai Jitsuyo Shinan Koho	1971-2009	Toroku Jitsuyo Shinan Koho	1994-2009

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2002-228353 A (Toshiba Corp.), 14 August, 2002 (14.08.02), Claim 1; Par. Nos. [0015] to [0017]; Figs. 1, 2 (Family: none)	1-7 8
Y	JP 2002-235976 A (Toshiba Corp.), 23 August, 2002 (23.08.02), Claims 2, 4; Par. Nos. [0009], [0011], [0022], [0033]; Figs. 1, 4 (Family: none)	8
Y	JP 2005-308294 A (Matsushita Electric Industrial Co., Ltd.), 04 November, 2005 (04.11.05), Claim 1; Par. Nos. [0001] to [0035], [0042] to [0058]; Fig. 3 (Family: none)	9-11

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"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
"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
"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
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search 21 May, 2009 (21.05.09)	Date of mailing of the international search report 02 June, 2009 (02.06.09)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/001108

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 06-185847 A (Matsushita Refrigeration Co.), 08 July, 1994 (08.07.94), Claim 2; Par. Nos. [0001] to [0033]; Figs. 3 to 5 (Family: none)	9-11
A	JP 2006-308504 A (Ishizuka Electronics Corp.), 09 November, 2006 (09.11.06), Par. Nos. [0007] to [0016], [0024]; Fig. 2 (Family: none)	1-8
A	JP 2008-107069 A (Sanyo Electric Co., Ltd.), 08 May, 2008 (08.05.08), Full text (Family: none)	9-11

Form PCT/ISA/210 (continuation of second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/001108

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The technical feature common to the inventions of claims 1-8 and the inventions of claims 9-11 relates to a refrigerator including a storage chamber having a non-contact sensor for detecting a temperature of food.

However, the search has revealed that the common technical feature is not novel since it is disclosed in JP 2002-22853 A.

As a result, the common technical feature makes no contribution over the prior art and cannot be a special technical feature within the meaning of PCT Rule 13.2, second sentence.

(Continued to extra sheet)

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest the

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/001108

Continuation of Box No.III of continuation of first sheet(2)

Since there exists no other common feature which can be considered as a special technical feature within the meaning of PCT Rule 13.2, second sentence, no technical relationship within the meaning of PCT Rule 13 between the different inventions can be seen.

Consequently, it is obvious that the inventions of claims 1-8 and the inventions of claims 9-11 do not satisfy the requirement of unity of invention.

Form PCT/ISA/210 (extra sheet) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2007212053 A **[0023]**
- JP 3454522 B **[0023]**