

[Name of Document] DESCRIPTION

[Title of Invention] REFRIGERATOR

[Technical Field]

[0001]

5 The present invention relates to refrigerators equipped with an illumination device in a storage compartment thereof.

[Background Art]

[0002]

10 In conventional arts, illumination devices for a storage compartment of a refrigerator have been proposed. One such illumination device is disposed in a ceiling of a storage compartment. Light emitted from the illumination device is inclined slightly toward the rear side with respect to a position immediately below the illumination device (for example, see Patent Literature 1).

[Citation List]

15 [Patent Literature]

[0003]

[Patent Literature 1] Japanese Unexamined Patent Application Publication No. 2007-3037 (page 3 and Fig. 2)

[Summary of Invention]

20 [Technical Problem]

[0004]

25 Illumination directions of related-art illumination devices for a refrigerator are directed toward a position substantially below the illumination device or slightly inclined toward the rear side. Thus, when the user, for example, selects a piece of food to take out of the storage compartment, the piece of food pulled forward from the shelf of the storage compartment is not sufficiently illuminated, and accordingly, labeling or the like of the food is not clearly visible. For this reason, the user needs to take the food out of the storage compartment and expose the food to indoor lighting in order to check the labeling of the food. Thus, there is a demand for improvement in usability for selecting and taking out food.

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[0005]

The storage compartment of the conventional refrigerator is separated in the up-down direction by transparent shelves. However, when a number of pieces of food are placed on the transparent shelves, the food blocks light emitted from the illumination device disposed in the ceiling of the storage compartment. As a result, the inside of the storage compartment becomes dark and food is not clearly visible.

[0006]

Example embodiments of the present invention are proposed in order to address the above described problem and provides a refrigerator in which, even when food is pulled forward from the storage compartment or pulled forward in the storage compartment, the food can still be illuminated. The example embodiments also provide a refrigerator in which the inside of the storage compartment can be more brightly illuminated.

[Solution to Problem]

[0007]

In accordance with an aspect, there is provided a refrigerator comprising: a storage compartment; at least one shelf that is formed of a light-transmissive material and separates the storage compartment in an up-down direction; a first illumination device that is provided in a ceiling of the storage compartment at a position closer to a front side of the storage compartment than a substantially central portion in a depth direction of the ceiling of the storage compartment, a direction of a center line of an area to be illuminated by the first illumination device is inclined toward the front side of the storage compartment with respect to a position immediately below the first illumination device; and a second illumination device that is provided below one of the at least one shelves and emits light directed toward the front side of the storage compartment, wherein the storage compartment is illuminated from above by light from the first illumination device and from below by light emitted from the second illumination device through the one of the at least one shelves.

[Advantageous Effects of Invention]

[0008]

In example embodiments, the first illumination device is provided in the ceiling of the storage compartment at the position closer to the front side than the substantially central portion in the depth direction of the storage compartment and emits light directed toward the front side of the storage compartment with respect to

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the position immediately below the first illumination device. Thus, when the user pulls forward food from the storage compartment, the food is illuminated by at least part of light emitted from the first illumination device. Thus, food becomes more clearly visible when the user takes the food out of the storage compartment.

5 [0009]

In example embodiments, the second illumination device is also provided below one of the at least one shelves and emits light directed toward the front side of the storage compartment. Thus, the inside of the storage compartment is illuminated from above by light emitted from the first illumination device and from below by light
10 emitted from the second illumination device. Since the inside of the storage compartment can be brightly illuminated, food in the storage compartment becomes more clearly visible. Furthermore, when the light from the first illumination device is blocked by, for example, food placed on the shelf of the storage compartment, a portion of the storage compartment below the shelf can be illuminated by the light
15 from the second illumination device.

[Brief Description of Drawings]

[0010]

[Fig. 1] Fig. 1 is a front view of a refrigerator according to Embodiments 1 and 2 with doors of the refrigerator removed.

20 [Fig. 2] Fig. 2 is a schematic sectional view of the refrigerator according to Embodiments 1 and 2 taken along line A-A in Fig. 1.

[Fig. 3] Fig. 3 is a perspective view of a main portion of a first illumination device according to Embodiments 1 and 2.

25 [Fig. 4] Fig. 4 is a perspective view of the main portion of the first illumination device according to Embodiment 1 with a cover of the first illumination device removed.

[Fig. 5] Fig. 5 is a perspective view of a main portion of a second illumination device according to Embodiments 1 and 2.

30 [Fig. 6] Fig. 6 is a perspective view of the main portion of the second illumination device according to Embodiment 1 with a cover of the second illumination device removed.

[Fig. 7] Fig. 7 is a perspective view of a main portion of a first illumination device according to Embodiment 2 with a cover of the first illumination device removed.

[Fig. 8] Fig. 8 is a perspective view of a main portion of a second illumination device according to Embodiment 2 with a cover of the second illumination device removed.

5 [Fig. 9] Fig. 9 is a front view of a refrigerator compartment according to Embodiment 3.

[Fig. 10] Fig. 10 is a schematic sectional view of the refrigerator compartment according to Embodiment 3 taken along line B-B in Fig. 9.

10 [Fig. 11] Fig. 11 is a perspective view of a main portion of a second illumination device according to Embodiment 3.

[Fig. 12] Fig. 12 is a front view of a refrigerator compartment according to Embodiment 4.

[Fig. 13] Fig. 13 is a perspective view of the refrigerator compartment according to Embodiment 4.

15 [Fig. 14] Fig. 14 is a perspective view of a transparent shelf according to Embodiment 4.

[Description of Embodiments]

[0011]

20 Embodiments in which a refrigerator according to the present invention is applied to an indirect-cooling refrigerator will be described below with reference to the drawings. The present invention is not limited by configurations illustrated in the drawings referred to below. Like reference signs denote like elements or their equivalents in the drawings. This is also applicable throughout the description.

[0012]

25 Embodiment 1

[General Structure of Refrigerator]

Fig. 1 is a front view of a refrigerator according to Embodiment 1 with doors of the refrigerator removed. Fig. 2 is a schematic sectional view of the refrigerator according to Embodiment 1 taken along line A-A in Fig. 1.

A refrigerator 1 includes an outer casing 2 formed of a steel sheet, an inner casing 3 formed of resin, and a heat insulation material 4 foamed and filled into a space between the outer casing 2 and the inner casing 3. The outer casing 2, the inner casing 3, and the heat insulating material 4 define the shell of the refrigerator 1.

5 The inside of the inner casing 3 of the refrigerator 1 is separated in the up-down direction by a heat insulating separation wall 11, thereby defining two storage compartments. The storage compartment formed in an upper portion defines a refrigerator compartment 5 and the storage compartment formed in a lower portion defines a freezer compartment 6. The temperature set for the freezer compartment 6 is lower than that for the refrigerator compartment 5. A refrigerator compartment door 7 is provided on a front surface of the refrigerator compartment 5, and a freezer compartment door 8 is provided on a front surface of the freezer compartment 6. In Embodiment 1, an example is described, in which the structure according to the present invention is applied to the refrigerator compartment 5.

15 [0013]

Next, a configuration of a refrigeration cycle implemented in the refrigerator 1 and a flow of air in the refrigerator 1 are described.

As illustrated in Fig. 2, the refrigerator 1 includes a compressor 12 in a lowermost portion on the rear surface side thereof. A refrigerant compressed by the compressor 12 is condensed by a condenser (not shown). The condensed refrigerant is decompressed by a capillary (not shown), which serves as a pressure reducer. The decompressed refrigerant evaporates in a cooler 13. A space around the cooler 13 is cooled by heat removal occurring due to the evaporation. The compressor 12, the condenser (not shown), the capillary (not shown) serving as the pressure reducer, and the cooler 13 form a refrigeration cycle.

A fan 14 causes the air cooled in the space around the cooler 13 to flow toward the refrigerator compartment 5 and the freezer compartment 6.

[0014]

A cold air blowing duct 17 formed of, for example, polystyrene foam, is provided on the rear surface side of the refrigerator compartment 5. Cold air is

directed into the refrigerator compartment 5 through the cold air blowing duct 17. A control panel 15 formed of synthetic resin is provided on the front side of the cold air blowing duct 17 so as to cover the cold air blowing duct 17. The control panel 15 defines a wall surface of the refrigerator compartment 5 on the rear surface side. One or a plurality of cold air outlets are open in the control panel 15. The refrigerator compartment 5 and the cold air blowing duct 17 communicate with each other through the cold air outlets of the control panel 15. Cold air from the fan 14 flows through the cold air blowing duct 17 and is blown into the refrigerator compartment 5 through the cold air outlets of the control panel 15.

[0015]

A damper (not shown) provided in the cold air blowing duct 17, the compressor 12, and the fan 14 are controlled by a controller (not shown) such as a control circuit. The controller detects the temperatures of the refrigerator compartment 5 and the freezer compartment 6 using a temperature detecting devices such as thermistors and controls the cooling capacity of the refrigeration cycle, starting and stopping of cooling operation, opening and closing of the damper, and operational state of the fan 14 so that the set target temperatures are attained in the storage compartments.

[0016]

[Structure of Refrigerator Compartment]

(Structure inside Refrigerator Compartment)

As illustrated in Figs. 1 and 2, a plurality of drawer cases 18 are provided in a lower portion of the refrigerator compartment 5, and a plurality of transparent shelves 20 are removably provided above the drawer cases 18. The transparent shelves 20 are formed of a light-transmissive material such as transparent glass or transparent synthetic resin. A space above the drawer cases 18 of the refrigerator compartment 5 is separated in the up-down direction by the transparent shelves 20. The user can place food on the transparent shelves 20. The lowermost transparent shelf 20 (this shelf may be referred to as a "transparent shelf 201" for distinction) is provided above the drawer cases 18 and defines a bottom surface of the space above the drawer cases 18. The drawer cases 18 are not necessarily provided. Although four

transparent shelves 20 are provided in the example described in Embodiment 1, it is sufficient that at least one transparent shelf 20 be provided.

[0017]

(First Illumination Device)

5 A first illumination device 30 is described with reference to Figs. 1 to 4.

Fig. 3 is a perspective view of a main portion of a first illumination device according to Embodiment 1. Fig. 4 is a perspective view of the main portion of the first illumination device according to Embodiment 1 with a cover of the first illumination device removed.

10 The first illumination device 30 is provided in a ceiling 16 of the refrigerator compartment 5. More specifically, the first illumination device 30 is located at a position closer to the front surface side (on the left side of the page of Fig. 2) than a substantially central portion in a depth direction of the refrigerator compartment 5. The first illumination device 30 occupies from about 50 to 90% of the inside of the refrigerator compartment 5 in terms of the width.

[0018]

As illustrated in Fig. 4, the first illumination device 30 includes a mounting board 32, a holder unit 33, and a cover 34. A plurality of light emitting diodes 31 (LEDs) that emit white light are mounted on the mounting board 32. The holder unit 33 holds the mounting board 32, and the cover 34 covers the mounting board 32. The mounting board 32 has a shape elongated in the width direction and is provided in the holder unit 33 such that the longitudinal direction thereof matches the width direction of the refrigerator compartment 5. The plurality of LEDs 31 that serve as light sources are spaced apart with one another at specified intervals in the longitudinal direction of the mounting board 32. Although an example in which the LEDs 31 are used as the light sources is described, the light sources are not limited to LEDs. Leads (not shown) are connected to the mounting board 32 for energizing the mounting board 32. The energizing state of the mounting board 32 is controlled by the controller (not shown). The mounting board 32 is attached to the ceiling 16 of the refrigerator compartment 5 through the holder unit 33. The cover 34, which is

formed of, for example, light-transmissive glass, synthetic resin, or the like, is attached so as to cover a light exit side of the LEDs 31.

[0019]

The first illumination device 30 emits light that is directed toward the front side in the depth direction with respect to a position immediately below the first illumination device 30, and preferably inclined toward the front side in the depth direction by about 1 to 5° relative to a direction toward the position immediately below the first illumination device 30. The illumination direction of the first illumination device 30 is set in a specified direction by, for example, holding the mounting board 32, which is inclined by a desired angle, using the holder unit 33. The illumination direction of the first illumination device 30 refers to a direction of the center line of an area to be illuminated (illumination angle) by the first illumination device 30.

[0020]

(Second Illumination Device)

Next, a second illumination device 40 is described with reference to Figs. 1, 2, 5 to 6.

Fig. 5 is a perspective view of a main portion of a second illumination device according to Embodiment 1. Fig. 6 is a perspective view of the main portion of the second illumination device according to Embodiment 1 with a cover of the second illumination device removed.

The second illumination device 40 is provided on the control panel 15 that defines the wall surface of the refrigerator compartment 5 on the rear surface side. More specifically, the second illumination device 40 is located at a position below the upper three transparent shelves 20 and slightly above the lowermost transparent shelf 201. In Embodiment 1, the second illumination device 40 is located at an area below a substantially central portion of the refrigerator compartment 5 in the height direction. The second illumination device 40 is preferably provided in the lower portion of the refrigerator compartment 5 where light emitted from the first illumination device 30 is comparatively difficult to reach. The second illumination device 40 occupies from about 50 to 90% of the inside of the refrigerator compartment 5 in terms of the width.

[0021]

The second illumination device 40 includes a mounting board 42, a holder unit 43, and a cover 44. A plurality of LEDs 41 that emit white light are mounted on the mounting board 42. The holder unit 43 holds the mounting board 42, and the cover 44 covers the mounting board 42. The mounting board 42 has a shape elongated in the width direction and is set such that the longitudinal direction thereof matches the width direction of the refrigerator compartment 5. The plurality of LEDs 41 that serve as light sources are spaced apart with one another at specified intervals in the longitudinal direction of the mounting board 42. Although an example in which the LEDs 41 are used as the light sources is described, the light sources are not limited to LEDs. Leads (not shown) are connected to the mounting board 42 for energizing the mounting board 42. The energizing state of the mounting board 42 is controlled by the controller (not shown). The mounting board 42 is attached to the control panel 15 through the holder unit 43. The cover 44, which is formed of, for example, light-transmissive glass, synthetic resin, or the like, is attached so as to cover a light exit side of the LEDs 41.

[0022]

The second illumination device 40 emits light in a direction inclined upward relative to the horizontal direction. Since the second illumination device 40 is attached in the lower portion of the refrigerator compartment 5, light emitted from the second illumination device 40 is directed upward from the lower portion of the refrigerator compartment 5 on the rear surface side so as to illuminate the inside of the refrigerator compartment 5. The illumination direction of the second illumination device 40 refers to a direction of the center line of an area to be illuminated (illumination angle) by the second illumination device 40.

[0023]

[Operation]

Operation of the thus structured refrigerator 1 according to Embodiment 1 is described below.

A door open/close sensor (not shown), which detects whether the refrigerator compartment door 7 is open or closed, is provided in the refrigerator compartment 5. When the refrigerator compartment door 7 is closed, neither of the mounting board 32 and the mounting board 42 is energized, and accordingly, the inside of the refrigerator compartment 5 is not illuminated. When the refrigerator compartment door 7 is opened, forward currents flow through the mounting boards 32 and 42, thereby causing the LEDs 31 and 41 to emit white light. The white light emitted from the LEDs 31 and 41 is transmitted through the covers 34 and 44 and illuminates the inside of the refrigerator compartment 5. The light that illuminates the inside of the refrigerator compartment 5 is transmitted through the light-transmissive transparent shelves 20 and illuminates food placed on the transparent shelves 20. Since the first illumination device 30 and the second illumination device 40 each largely extend inside the refrigerator compartment 5, that is, each occupy about 50 to 90% of the inside of the refrigerator compartment 5 in terms of the width, light easily reaches left and right side wall sides of the refrigerator compartment 5. This allows the inside of the refrigerator compartment 5 to be more brightly illuminated.

[0024]

The light emitted from the first illumination device 30 is inclined toward the front side by 1 to 5° (for example, 1°) relative to a direction toward the position immediately below the first illumination device 30. With this illumination, when food in the refrigerator compartment 5 is pulled forward from the transparent shelves 20 or pulled forward on the transparent shelves 20 by the user, at least part of the light emitted from the first illumination device 30 illuminates the food having been pulled forward from or pulled forward on the transparent shelves 20. Thus, labeling or the like of the food pulled forward from or pulled forward on the transparent shelves 20 becomes more clearly visible. Accordingly, in order to check labeling or the like of the food, the user can easily check labeling or the like of the food without completely taking the food out of the refrigerator compartment 5 and exposing the food to indoor lighting. This improves usability of the refrigerator 1.

[0025]

The light emitted from the second illumination device 40 is directed upward from the lower portion of the refrigerator compartment 5 on the rear surface side so as to illuminate the inside of the refrigerator compartment 5. Thus, the inside of the refrigerator compartment 5 is illuminated from above by light emitted from the first illumination device 30 and from below by light emitted from the second illumination device 40. Accordingly, when a number of pieces of food are placed, for example, on the upper transparent shelves 20 and the light from the first illumination device 30 is blocked by these pieces of food, a portion of the refrigerator compartment 5 below these transparent shelves 20 is illuminated by the light from the second illumination device 40. Furthermore, when a number of pieces of food are placed, for example, on the lower transparent shelves 20 and the light from the second illumination device 40 is blocked by these pieces of food, a portion of the refrigerator compartment 5 above these transparent shelves 20 is illuminated by the light from the first illumination device 30. Thus, according to Embodiment 1, the inside of the refrigerator compartment 5 can be more brightly illuminated and food placed therein becomes more clearly visible.

[0026]

Embodiment 2

In Embodiment 2, the differences between Embodiments 1 and 2 are mainly described.

The structures of the refrigerator 1 according to Embodiment 2 illustrated in Figs. 1, 2, 3, and 5 are similar to that of Embodiment 1.

[0027]

As illustrated in Figs. 1 to 3 and 5, the refrigerator 1 includes the outer casing 2 formed of a steel sheet, the inner casing 3 formed of resin, and the heat insulation material 4 foamed and filled into a space between the outer casing 2 and the inner casing 3. The outer casing 2, the inner casing 3, and the heat insulating material 4 define the shell of the refrigerator 1. The inside of the inner casing 3 of the refrigerator 1 is separated in the up-down direction by the heat insulating separation wall 11, thereby defining the refrigerator compartment 5 in the upper portion and the

freezer compartment 6 in the lower portion. The refrigerator compartment door 7 is provided on the front surface of the refrigerator compartment 5, and the freezer compartment door 8 is provided for the freezer compartment 6. These structures are similar to those of Embodiment 1.

5 [0028]

Similarly to Embodiment 1, the plurality of drawer cases 18 and the plurality of transparent shelves 20 are provided in the refrigerator compartment 5.

[0029]

(First Illumination Device)

10 A first illumination device 30A according to Embodiment 2 is described with reference to Figs. 1, 2, 3, and 7.

Fig. 7 is a perspective view of the main portion of a first illumination device according to Embodiment 2 with a cover of the first illumination device removed.

[0030]

15 The first illumination device 30A is provided in the ceiling 16 of the refrigerator compartment 5. More specifically, the first illumination device 30A is located at a position closer to the front surface side (on the left side of the page of Fig. 2) than the substantially central portion in the depth direction of the refrigerator compartment 5. The first illumination device 30A occupies from about 50 to 90% of the inside of the
20 refrigerator compartment 5 in terms of the width.

[0031]

As illustrated in Fig. 7, the first illumination device 30A according to Embodiment 2 includes a plurality of mounting boards 35a and 35b (the mounting boards 35a and 35b may be collectively referred to as "mounting boards 35"
25 hereafter), the holder unit 33, and the cover 34. The plurality of LEDs 31 that emit white light are mounted on the plurality of mounting boards 35. The holder unit 33 holds the plurality of mounting boards 35, and the cover 34 covers the plurality of mounting boards 35. The mounting boards 35 each have a shape elongated in the width direction. The mounting boards 35 are arranged in series with each other with
30 respect to the longitudinal direction thereof in the holder unit 33. The plurality of

mounting boards 35 are disposed such that the longitudinal direction thereof matches the width direction of the refrigerator compartment 5. The plurality of LEDs 31 are spaced apart with one another at specified intervals in the longitudinal direction of the mounting boards 35. Leads (not shown) are connected to the mounting boards 35 for energizing the mounting boards 35. The energizing states of the mounting boards 35 are controlled by the controller (not shown). The mounting boards 35 are attached to the ceiling 16 of the refrigerator compartment 5 through the holder unit 33. The cover 34, which is formed of, for example, light-transmissive glass, synthetic resin, or the like, is attached so as to cover the light exit side of the LEDs 31. Although an example in which the mounting boards 35 include two mounting boards 35 is described in Embodiment 2, three or more mounting boards 35 may be provided.

[0032]

The first illumination device 30A emits light that is directed toward the front side in the depth direction with respect to a position immediately below the first illumination device 30A, and preferably inclined toward the front side in the depth direction by about 1 to 5° relative to a direction toward the position immediately below the first illumination device 30A. The illumination direction of the first illumination device 30A is set in a specified direction by, for example, holding the mounting boards 35, which is inclined by a desired angle, using the holder unit 33.

[0033]

(Second Illumination Device)

A second illumination device 40A according to Embodiment 2 is described with reference to Figs. 1, 2, 5, and 8.

Fig. 8 is a perspective view of a main portion of a second illumination device according to Embodiment 2 with a cover of the second illumination device removed.

[0034]

The second illumination device 40A is provided on the control panel 15 that defines the wall surface of the refrigerator compartment 5 on the rear surface side. More specifically, the second illumination device 40A is located at a position below the upper three transparent shelves 20 and slightly above the lowermost transparent shelf

201. In Embodiment 2, the second illumination device 40A is located at the area below the substantially central portion of the refrigerator compartment 5 in the height direction. The second illumination device 40A is preferably provided in the lower portion of the refrigerator compartment 5 where light emitted from the first illumination device 30A is comparatively difficult to reach. The second illumination device 40A occupies from about 50 to 90% of the inside of the refrigerator compartment 5 in terms of the width.

[0035]

The second illumination device 40A includes a plurality of mounting boards 45a and 45b (the mounting boards 45a and 45b may be collectively referred to as "mounting boards 45" hereafter), the holder unit 43, and the cover 44. A plurality of LEDs 41 that emit white light are mounted on the plurality of mounting boards 45. The holder unit 43 holds the plurality of mounting boards 45, and the cover 44 covers the plurality of mounting boards 45. The mounting boards 45 each have a shape elongated in the width direction. The mounting boards 45 are arranged in series with each other with respect to the longitudinal direction thereof in the holder unit 43. The plurality of mounting boards 45 are disposed such that the longitudinal direction thereof matches the width direction of the refrigerator compartment 5. Leads (not shown) are connected to the mounting boards 45 for energizing the mounting boards 45. The energizing states of the mounting boards 45 are controlled by the controller (not shown). The mounting boards 45 are attached to the control panel 15 through the holder unit 43. The cover 44, which is formed of, for example, light-transmissive glass, synthetic resin, or the like, is attached so as to cover a light exit side of the LEDs 41. Although an example in which the mounting boards 45 include two mounting boards 45 is described in Embodiment 2, three or more mounting boards 45 may be provided.

[0036]

The second illumination device 40A emits light in a direction inclined upward relative to the horizontal direction. Since the second illumination device 40A is attached in the lower portion of the refrigerator compartment 5, light emitted from the

second illumination device 40A is directed upward from the lower portion of the refrigerator compartment 5 on the rear surface side so as to illuminate the inside of the refrigerator compartment 5.

[0037]

5 [Operation]

Operation of the thus structured refrigerator 1 according to Embodiment 2 is described below.

The door open/close sensor (not shown), which detects whether the refrigerator compartment door 7 is open or closed, is provided in the refrigerator compartment 5.

10 When the refrigerator compartment door 7 is closed, neither of the mounting boards 35 and the mounting boards 45 is energized, and accordingly, the inside of the refrigerator compartment 5 is not illuminated. When the refrigerator compartment door 7 is opened, forward currents flow through the mounting boards 35 and 45, thereby causing the LEDs 31 and 41 to emit white light. The white light emitted from
15 the LEDs 31 and 41 is transmitted through the covers 34 and 44 and illuminates the inside of the refrigerator compartment 5. The light that illuminates the inside of the refrigerator compartment 5 is transmitted through the light-transmissive transparent shelves 20 and illuminates food placed on the transparent shelves 20. Since the first illumination device 30A and the second illumination device 40A each largely extend
20 inside the refrigerator compartment 5, that is, each occupy about 50 to 90% of the inside of the refrigerator compartment 5 in terms of the width, light easily reaches the left and right side wall sides of the refrigerator compartment 5. This allows the inside of the refrigerator compartment 5 to be more brightly illuminated.

[0038]

25 The light emitted from the first illumination device 30A is inclined toward the front side by 1 to 5° (for example, 1°) relative to a direction toward the position immediately below the first illumination device 30A. With this illumination, when food in the refrigerator compartment 5 is pulled forward from the transparent shelves 20 or pulled forward on the transparent shelves 20 by the user, at least part of the light
30 emitted from the first illumination device 30A illuminates the food having been pulled

forward from or pulled forward on the transparent shelves 20. Thus, labeling or the like of the food pulled forward from or pulled forward on the transparent shelves 20 becomes more clearly visible. Accordingly, in order to check labeling or the like of the food, the user can easily check labeling or the like of the food without completely taking the food out of the refrigerator compartment 5 and exposing the food to indoor lighting. This improves usability of the refrigerator 1.

[0039]

The light emitted from the second illumination device 40A is directed upward from the lower portion of the refrigerator compartment 5 on the rear surface side so as to illuminate the inside of the refrigerator compartment 5. Thus, the inside of the refrigerator compartment 5 is illuminated from above by light emitted from the first illumination device 30A and from below by light emitted from the second illumination device 40A. Accordingly, when a number of pieces of food are placed, for example, on the upper transparent shelves 20 and the light from the first illumination device 30A is blocked by these pieces of food, the portion of the refrigerator compartment 5 below these transparent shelves 20 is illuminated by the light from the second illumination device 40A. Furthermore, when a number of pieces of food are placed, for example, on the lower transparent shelves 20 and the light from the second illumination device 40A is blocked by these pieces of food, the portion of the refrigerator compartment 5 above these transparent shelves 20 is illuminated by the light from the first illumination device 30A. Thus, according to Embodiment 2, the inside of the refrigerator compartment 5 can be more brightly illuminated and food placed therein becomes more clearly visible.

[0040]

In Embodiment 2, the first illumination device 30A and the second illumination device 40A respectively include the plurality of mounting boards 35 and the plurality of mounting boards 45. This allows the length in the long side of a single mounting board 35 in comparison with that of the first illumination device 30A and the length in the long side of a single mounting board 45 in comparison with that of the second illumination device 40A to be reduced. Accordingly, when each mounting board 35

and each mounting board 45 are respectively attached to the holder unit 33 and 43, and when the leads for energizing are connected to each mounting board 35 and each mounting board 45, stress acting on each mounting board 35 and each mounting board 45 can be reduced. Thus, removal of mounted components and the like due to breaking or bending of the mounting boards 35 and 45 caused by stress can be reduced, and accordingly, the quality of the first illumination device 30A and the second illumination device 40A can be improved.

[0041]

The numbers of mounting boards 35 and 45 provided in the first illumination device 30A and the second illumination device 40A may be set with consideration of the cost and work efficiency. The first illumination device 30A and the second illumination device 40A may each include the plurality of mounting boards as described above. Alternatively, either one of the first illumination device 30A and the second illumination device 40A may include the plurality of mounting boards.

[0042]

Embodiment 3

In Embodiment 3, the differences between Embodiments 1 and 3 are mainly described.

Fig. 9 is a front view of the refrigerator compartment according to Embodiment 3. Fig. 10 is a schematic sectional view of the refrigerator compartment according to Embodiment 3 taken along line B-B in Fig. 9. Fig. 11 is a perspective view of a main portion of a second illumination device according to Embodiment 3.

[0043]

As illustrated in Figs. 9 and 10, the refrigerator 1 includes the outer casing 2 formed of a steel sheet, the inner casing 3 formed of resin, and the heat insulation material 4 foamed and filled into a space between the outer casing 2 and the inner casing 3. The outer casing 2, the inner casing 3, and the heat insulating material 4 define the shell of the refrigerator 1. The inside of the inner casing 3 of the refrigerator 1 is separated in the up-down direction by the heat insulating separation wall 11, thereby defining the refrigerator compartment 5 in the upper portion and the

freezer compartment 6 (not shown in Fig. 9 or 10) in the lower portion. The refrigerator compartment door 7 is provided on the front surface of the refrigerator compartment 5, and the freezer compartment door 8 is provided for the freezer compartment 6. These structures are similar to those of Embodiment 1.

5 [0044]

Although the plurality of drawer cases 18 and the plurality of transparent shelves 20 are provided in the refrigerator compartment 5 similarly to Embodiment 1, the structure of a lowermost transparent shelf 201B is different from that of Embodiment 1 as will be described later.

10 [0045]

(First Illumination Device)

The first illumination device 30 similar to that of Embodiment 1 is provided in the ceiling 16 of the refrigerator compartment 5. More specifically, the first illumination device 30 is located at a position closer to the front surface side than the substantially central portion in the depth direction of the refrigerator compartment 5. The first illumination device 30 occupies from about 50 to 90% of the inside of the refrigerator compartment 5 in terms of the width. The first illumination device 30 emits light that is directed toward the front side in the depth direction with respect to a position immediately below the first illumination device 30, and preferably inclined toward the front side in the depth direction by about 1 to 5° relative to a direction toward the position immediately below the first illumination device 30.

[0046]

(Second Illumination Device)

A second illumination device 40B is provided below the upper three transparent shelves 20 and below the substantially central portion of the refrigerator compartment 5 in the height direction on the rear surface side of the refrigerator compartment 5. As illustrated in Fig. 11, in Embodiment 3, an attachment unit 19 is provided below the control panel 15 that defines the wall surface of the refrigerator compartment 5 on the rear surface side. The attachment unit 19 has a plate shape that extends toward the front side. The second illumination device 40B is disposed at the end of the front side

of the attachment unit 19. That is, the second illumination device 40B is located closer to the front side in the depth direction than the second illumination device 40 described in Embodiment 1. The second illumination device 40B occupies from about 50 to 90% of the inside of the refrigerator compartment 5 in terms of the width. The structures of LEDs 41, the mounting board 42, the holder unit 43, and the cover 44, which are parts of the second illumination device 40B, are similar to those of Embodiment 1.

[0047]

The second illumination device 40B is located at a height at which the surface of the cover 44 defining the upper surface of the second illumination device 40B is substantially flush with a placement surface (upper surface) of the lowermost transparent shelf 201B. That is, the upper surface of the second illumination device 40B and the upper surface of the lowermost transparent shelf 201B are aligned with each other at heights substantially similar to each other, and the second illumination device 40B serves as part of a shelf on which food is placed.

[0048]

The second illumination device 40B emits light in a direction inclined upward relative to the horizontal direction. Since the second illumination device 40B is attached in the lower portion of the refrigerator compartment 5 at the same height as that of the lowermost transparent shelf 201B, light emitted from the second illumination device 40B is directed upward from the lower portion of the refrigerator compartment 5 on the rear surface side so as to illuminate the inside of the refrigerator compartment 5.

[0049]

[Operation]

Operation of the thus structured refrigerator 1 according to Embodiment 3 is described below.

The door open/close sensor (not shown), which detects whether the refrigerator compartment door 7 is open or closed, is provided in the refrigerator compartment 5. When the refrigerator compartment door 7 is closed, neither of the mounting board 32

and the mounting board 42 is energized, and accordingly, the inside of the refrigerator compartment 5 is not illuminated. When the refrigerator compartment door 7 is opened, forward currents flow through the mounting boards 32 and 42, thereby causing the LEDs 31 and 41 to emit white light. The white light emitted from the LEDs 31 and 41 is transmitted through the covers 34 and 44 and illuminates the inside of the refrigerator compartment 5. The light that illuminates the inside of the refrigerator compartment 5 is transmitted through the light-transmissive transparent shelves 20 and illuminates food placed on the transparent shelves 20. Since the first illumination device 30 and the second illumination device 40B each largely extend inside the refrigerator compartment 5, that is, each occupy about 50 to 90% of the inside of the refrigerator compartment 5 in terms of the width, light easily reaches the left and right side wall sides of the refrigerator compartment 5. This allows the inside of the refrigerator compartment 5 to be more brightly illuminated.

[0050]

The light emitted from the first illumination device 30 is inclined toward the front side by 1 to 5° (for example, 1°) relative to a direction toward the position immediately below the first illumination device 30. With this illumination, when food in the refrigerator compartment 5 is pulled forward from the transparent shelves 20 or pulled forward on the transparent shelves 20 by the user, at least part of the light emitted from the first illumination device 30 illuminates the food having been pulled forward from or pulled forward on the transparent shelves 20. Thus, labeling or the like of the food pulled forward from or pulled forward on the transparent shelves 20 becomes more clearly visible. Accordingly, in order to check labeling or the like of the food, the user can easily check labeling or the like of the food without completely taking the food out of the refrigerator compartment 5 and exposing the food to indoor lighting. This improves usability of the refrigerator 1.

[0051]

The light emitted from the second illumination device 40B is directed upward from the lower portion of the refrigerator compartment 5 on the rear surface side so as to illuminate the inside of the refrigerator compartment 5. Thus, the inside of the

refrigerator compartment 5 is illuminated from above by light emitted from the first illumination device 30 and from below by light emitted from the second illumination device 40B. Accordingly, when a number of pieces of food are placed, for example, on the upper transparent shelves 20 and the light from the first illumination device 30 is blocked by these pieces of food, the portion of the refrigerator compartment 5 below these transparent shelves 20 is illuminated by the light from the second illumination device 40B. Furthermore, when a number of pieces of food are placed, for example, on the lower transparent shelves 20 and the light from the second illumination device 40B is blocked by these pieces of food, the portion of the refrigerator compartment 5 above these transparent shelves 20 is illuminated by the light from the first illumination device 30. Thus, according to Embodiment 3, the inside of the refrigerator compartment 5 can be more brightly illuminated and food placed therein becomes more clearly visible.

[0052]

Furthermore, the second illumination device 40B together with the lowermost transparent shelf 201B serves as a shelf on which food is placed in Embodiment 3. Thus, compared to a case in which the lower most shelf of the refrigerator compartment 5 is formed only of a transparent shelf, the size of the lowermost transparent shelf 201B can be reduced without reducing the amount of food to be stored in the refrigerator compartment 5. This can reduce the cost of the refrigerator 1.

[0053]

Also in Embodiment 3, the second illumination device 40B is disposed so as to protrude closer to the front side than the control panel 15. Thus, light emitted from the second illumination device 40B more easily reaches the front side in the depth direction of the refrigerator compartment 5. Accordingly, the front side of the refrigerator compartment 5, on which the user tends to place food, can be effectively illuminated.

[0054]

Either or both of the first illumination device 30 and the second illumination device 40B of Embodiment 3 may include a plurality of mounting boards similarly to Embodiment 2.

[0055]

5 Embodiment 4

Fig. 12 is a front view of a refrigerator compartment according to Embodiment 4. Fig. 13 is a perspective view of the refrigerator compartment according to Embodiment 4. Fig. 14 is a perspective view of a transparent shelf according to Embodiment 4.

10 Embodiment 4 features a shelf that separates the space inside the refrigerator compartment 5 in the up-down direction. In Embodiment 4, the differences between Embodiments 1 and 4 are mainly described.

[0056]

15 As illustrated in Figs. 12 and 13, the refrigerator 1 includes the outer casing 2 formed of a steel sheet, the inner casing 3 formed of resin, and the heat insulation material 4 foamed and filled into a space between the outer casing 2 and the inner casing 3. The outer casing 2, the inner casing 3, and the heat insulating material 4 define the shell of the refrigerator 1. The inside of the inner casing 3 of the refrigerator 1 is separated in the up-down direction by the heat insulating separation wall 11, thereby defining the refrigerator compartment 5 in the upper portion and the freezer compartment 6 (not shown in Fig. 12 or 13) in the lower portion. The refrigerator compartment door 7 is provided on the front surface of the refrigerator compartment 5, and the freezer compartment door 8 is provided for the freezer compartment 6. These structures are similar to those of Embodiment 1.

25 [0057]

Similarly to Embodiment 1, the plurality of drawer cases 18 are provided in the refrigerator compartment 5. In Embodiment 4, a plurality of refrigerator compartment shelves 50 are removably provided instead of the plurality of transparent shelves 20 described in Embodiment 1.

30 [0058]

(First Illumination Device)

The first illumination device 30 similar to that of Embodiment 1 is provided in the ceiling 16 of the refrigerator compartment 5. More specifically, the first illumination device 30 is located at a position closer to the front surface side than the substantially central portion in the depth direction of the refrigerator compartment 5. The first illumination device 30 occupies from about 50 to 90% of the inside of the refrigerator compartment 5 in terms of the width. The first illumination device 30 emits light that is directed toward the front side in the depth direction with respect to a position immediately below the first illumination device 30, and preferably inclined toward the front side in the depth direction by about 1 to 5° relative to a direction toward the position immediately below the first illumination device 30.

[0059]

(Second Illumination Device)

The second illumination device 40 similar to that of Embodiment 1 is provided on the control panel 15 that defines the wall surface of the refrigerator compartment 5 on the rear surface side. More specifically, the second illumination device 40 is located at a position below the upper three refrigerator compartment shelves 50 and slightly above the lowermost refrigerator compartment shelf 50. In Embodiment 4, the second illumination device 40 is located at an area below the substantially central portion of the refrigerator compartment 5 in the height direction. The second illumination device 40 occupies from about 50 to 90% of the inside of the refrigerator compartment 5 in terms of the width.

[0060]

The second illumination device 40 emits light in a direction inclined upward relative to the horizontal direction. Since the second illumination device 40 is attached in the lower portion of the refrigerator compartment 5, light emitted from the second illumination device 40 is directed upward from the lower portion of the refrigerator compartment 5 on the rear surface side so as to illuminate the inside of the refrigerator compartment 5.

[0061]

(Refrigerator Compartment Shelf)

As illustrated in Figs. 12 to 14, the refrigerator compartment shelves 50 each include a flat plate-shaped placement plate 51, an outer frame 52, and a reflecting plate 53. Food is mainly placed on the placement plate 51. The outer frame 52 surrounds an outer periphery of the placement plate 51. The placement plate 51 is formed of a light-transmissive material, for example, such as transparent glass or transparent synthetic resin. The outer frame 52 is formed of a material such as, for example, translucent glass or translucent synthetic resin.

[0062]

The reflecting plate 53 is disposed in a front-side portion (may be referred to as a "front-side outer frame 521") of the outer frame 52 that surrounds the placement plate 51. The reflecting plate 53 reflects at least part of light emitted from the first illumination device 30, which is disposed in the ceiling 16 of the refrigerator compartment 5, toward the front-side of the refrigerator compartment 5. The direction in which light is reflected by the reflecting plate 53 is defined by, for example, the position where the reflecting plate 53 is disposed and the direction of a reflecting surface of the reflecting plate 53.

[0063]

[Operation]

Operation of the thus structured refrigerator 1 according to Embodiment 4 is described below.

The door open/close sensor (not shown), which detects whether the refrigerator compartment door 7 is open or closed, is provided in the refrigerator compartment 5. When the refrigerator compartment door 7 is closed, neither of the mounting board 32 and the mounting board 42 is energized, and accordingly, the inside of the refrigerator compartment 5 is not illuminated. When the refrigerator compartment door 7 is opened, forward currents flow through the mounting boards 32 and 42, thereby causing the LEDs 31 and 41 to emit white light. The white light emitted from the LEDs 31 and 41 is transmitted through the covers 34 and 44 and illuminates the inside of the refrigerator compartment 5. The light that illuminates the inside of the

refrigerator compartment 5 is transmitted through the light-transmissive placement plates 51 and the outer frames 52 of the refrigerator compartment shelves 50, and illuminates food placed on the refrigerator compartment shelves 50. Since the first illumination device 30 and the second illumination device 40 each largely extend
5 inside the refrigerator compartment 5, that is, each occupy about 50 to 90% of the inside of the refrigerator compartment 5 in terms of the width, light easily reaches the left and right side wall sides of the refrigerator compartment 5. This allows the inside of the refrigerator compartment 5 to be more brightly illuminated.

[0064]

10 The light emitted from the first illumination device 30 is inclined toward the front side by 1 to 5° (for example, 1°) relative to a direction toward the position immediately below the first illumination device 30. With this illumination, when food in the refrigerator compartment 5 is pulled forward from the refrigerator compartment shelves 50 or pulled forward on the refrigerator compartment shelves 50 by the user,
15 at least part of the light emitted from the first illumination device 30 illuminates the food having been pulled forward from or pulled forward on the refrigerator compartment shelves 50. Thus, labeling or the like of the food pulled forward from or pulled forward on the refrigerator compartment shelves 50 becomes more clearly visible. Accordingly, in order to check labeling or the like of the food, the user can
20 easily check labeling or the like of the food without completely taking the food out of the refrigerator compartment 5 and exposing the food to indoor lighting. This improves usability of the refrigerator 1.

[0065]

25 The light emitted from the second illumination device 40 is directed upward from the lower portion of the refrigerator compartment 5 on the rear surface side so as to illuminate the inside of the refrigerator compartment 5. Thus, the inside of the refrigerator compartment 5 is illuminated from above by light emitted from the first illumination device 30 and from below by light emitted from the second illumination device 40. Accordingly, when a number of pieces of food are placed, for example, on
30 the upper refrigerator compartment shelves 50 and the light from the first illumination

device 30 is blocked by these pieces of food, a portion of the refrigerator compartment 5 below these refrigerator compartment shelves 50 is illuminated by the light from the second illumination device 40. Furthermore, when a number of pieces of food are placed, for example, on the lower refrigerator compartment shelves 50 and the light from the second illumination device 40 is blocked by these pieces of food, a portion of the refrigerator compartment 5 above these refrigerator compartment shelves 50 is illuminated by the light from the first illumination device 30. Thus, according to Embodiment 4, the inside of the refrigerator compartment 5 can be more brightly illuminated and food placed therein becomes more clearly visible.

[0066]

Furthermore, the reflecting plate 53 is provided in the front-side outer frame 521 of each refrigerator compartment shelf 50 in Embodiment 4. With this structure, when the user opens the refrigerator compartment door 7, the reflecting plate 53 reflects at least part of light emitted from the first illumination device 30, which is disposed in the ceiling 16 of the refrigerator compartment 5, toward the front-side of the refrigerator compartment 5. Thus, the front side of the refrigerator compartment 5 can be particularly brightly illuminated without increasing the amount of light from the first illumination device 30. By brightly illuminating the inside of the refrigerator compartment 5 as described above, an improved impression of cleanliness can be obtained.

[0067]

Either or both of the first illumination device 30 and the second illumination device 40 of Embodiment 4 may include a plurality of mounting boards similarly to Embodiment 2.

[0068]

By combining Embodiment 3 and Embodiment 4, part of the second illumination device 40 together with the lowermost refrigerator compartment shelf 50 serves as part of the shelf.

[Reference Signs List]

[0069]

1 refrigerator, 2 outer casing, 3 inner casing, 4 heat insulating material, 5
refrigerator compartment, 6 freezer compartment, 7 refrigerator compartment door, 8
freezer compartment door, 11 separation wall, 12 compressor, 13 cooler, 14 fan, 15
control panel, 16 ceiling, 17 cold air blowing duct, 18 drawer case, 19 attachment
5 unit, 20 transparent shelf, 30 first illumination device, 30A first illumination device,
31 LED, 32 mounting board, 33 holder unit, 34 cover, 35 mounting board, 35a, 35b
mounting board, 40 second illumination device, 40A second illumination device, 40B
second illumination device, 41 LED, 42 mounting board, 43 holder unit, 44 cover,
45 mounting board, 45a, 45b mounting boards, 50 refrigerator compartment shelf,
10 51 placement plate, 52 outer frame, 53 reflecting plate, 201 lowermost transparent
shelf, 201B lowermost transparent shelf, and 521 front-side outer frame.

[Name of Document] CLAIMS

[Claim 1]

A refrigerator comprising:

a storage compartment;

5 at least one shelf that is formed of a light-transmissive material and separates the storage compartment in an up-down direction;

10 a first illumination device that is provided in a ceiling of the storage compartment at a position closer to a front side of the storage compartment than a substantially central portion in a depth direction of the ceiling of the storage compartment, a direction of a center line of an area to be illuminated by the first illumination device is inclined toward the front side of the storage compartment with respect to a position immediately below the first illumination device; and

15 a second illumination device that is provided below one of the at least one shelves and emits light directed toward the front side of the storage compartment,

20 wherein the storage compartment is illuminated from above by light from the first illumination device and from below by light emitted from the second illumination device through the one of the at least one shelves.

[Claim 2]

The refrigerator of Claim 1,

25 wherein the direction of the center line of the area to be illuminated by the first illumination device is inclined toward the front side of the storage compartment by 1 to 5° relative to a direction toward the position immediately below the first illumination device.

[Claim 3]

The refrigerator of Claim 1 or 2,

30 wherein the second illumination device is provided below a substantially central portion of the storage compartment in a height direction.

[Claim 4]

The refrigerator of any one of Claims 1 to 3,

35 wherein the second illumination device emits light directed upward relative to a horizontal direction.

[Claim 5]

The refrigerator of any one of Claims 1 to 4,

wherein the first illumination device occupies from 50 to 90% of the storage compartment in terms of the width.

[Claim 6]

The refrigerator of any one of Claims 1 to 5,

5 wherein the second illumination device occupies from 50 to 90% of the storage compartment in terms of the width.

[Claim 7]

The refrigerator of any one of Claims 1 to 6,

10 wherein the first illumination device includes a plurality of first mounting boards, on each of which a plurality of light sources are mounted, and

wherein the plurality of first mounting boards are arranged in series with one another in a long side direction of the first mounting boards.

[Claim 8]

The refrigerator of any one of Claims 1 to 7,

15 wherein the second illumination device includes a plurality of second mounting boards, on each of which a plurality of light sources are mounted, and

wherein the plurality of second mounting boards are arranged in series with one another in a long side direction of the second mounting boards.

[Claim 9]

20 The refrigerator of any one of Claims 1 to 8,

wherein the second illumination device is provided on a wall surface of the storage compartment on a rear surface side.

[Claim 10]

The refrigerator of any one of Claims 1 to 8,

25 wherein the at least one shelf includes a plurality of the shelves arranged in the up-down direction of the storage compartment,

wherein the second illumination device includes a light-transmissive cover that covers a light exit side of light sources, and

30 wherein an upper surface of the cover is substantially flush with an upper surface of one of the plurality of shelves except for the uppermost shelf.

[Claim 11]

The refrigerator of Claim 10,
wherein the upper surface of the cover is substantially flush with an upper
surface of the lowermost shelf out of the plurality of shelves.

5

[Claim 12]

The refrigerator of any one of Claims 1 to 11, further comprising:
a reflecting plate disposed on a front side of the at least one shelf so as to
extend along a width of the shelf, the reflecting plate reflecting toward the front side of
the storage compartment at least part of light emitted from the first illumination device.