

DESCRIPTION

Title of Invention

REFRIGERATOR

Technical Field

5 [0001]

The present invention relates to refrigerators, and more particularly, to configurations of operation displays of refrigerators.

Background Art

[0002]

10 In recent years, refrigerators commonly have an operation display (operation display panel) of a touch sensor type. The operation display is typically configured to display a touch operation section, icons, or characters with improved visibility by emitting light from a light emitting source.

[0003]

15 Furthermore, the touch operation section of the operation display also has a power saving function so that the touch operation section is usually turned off when not in operation and turned on only when in operation.

[0004]

20 For users of advanced age, a certain size of a light emitting area is desirable for the touch operation section, icons, and character display section. Consequently, a number of light guides are often used to enable surface emission (for example, see Patent Literature 1).

Citation List

Patent Literature

25 [0005]

Patent Literature 1: Utility Model Registration No. 3172080

Summary of Invention

Technical Problem

[0006]

When a number of light guides are used to enable surface emission, a light guide is necessary for each of the touch operation section, icons, and character display section (for example, 30 pieces of light guides are necessary for 30 elements to be lighted). Such an increase in the number of components causes poor productivity, increased costs, and inconsistent quality.

[0007]

The present invention has been made to overcome the above problems, and an object of the invention is to provide a refrigerator having an operation display formed with a reduced number of components and having improved productivity, reduced costs, and consistent quality even when the operation display is caused to enable surface emission.

Solution to Problem

[0008]

A refrigerator according to an embodiment of the present invention is a refrigerator that includes an operation display. The operation display includes a transparent plate member, a multilayer sheet disposed on a rear side of the transparent plate member and configured to detect at least change in capacitance, and an electronic substrate disposed on a side of the multilayer sheet opposite to the transparent plate member, the electronic substrate including a plurality of light emitting sources configured to emit light toward the multilayer sheet, and including a controller configured to receive a signal detected by the multilayer sheet as an operation signal and control the plurality of light emitting sources to emit light. The multilayer sheet includes a transparent base material, a plurality of transparent conductive members disposed on a surface of the transparent base material facing the transparent plate member and configured to detect change in capacitance, a light shielding layer disposed on a surface of the transparent base material on a side of the electronic substrate and includes a pattern configured to display a shape of at least one of characters and symbols, and a light diffusing layer disposed on a surface of the light shielding layer on a side of the electronic substrate and configured to diffuse light emitted from the plurality of light emitting sources. The light shielding layer, the

light diffusing layer, and the plurality of transparent conductive members are printed on the same transparent base material.

Advantageous Effects of Invention

[0009]

5 In the refrigerator according to an embodiment of the present invention, the above configuration of the operation display enables a significant reduction in the number of components of the operation display, thereby achieving improved productivity, reduced costs, and constant quality.

Brief Description of Drawings

10 [0010]

 [Fig. 1] Fig. 1 is a front view of a refrigerator according to Embodiment 1 of the present invention.

 [Fig. 2] Fig. 2 is a cross-sectional side view of the refrigerator in Fig. 1.

15 [Fig. 3] Fig. 3 is an exploded perspective view of an operation display panel in Fig. 1.

 [Fig. 4] Fig. 4 is detailed views of components of the operation display panel in Fig. 3.

 [Fig. 5] Fig. 5 is an outer appearance view of the transparent electrode sheet in Fig. 3.

20 [Fig. 6] Fig. 6 is a cross-sectional view of the transparent electrode sheet in Fig. 5.

 [Fig. 7] Fig. 7 is a cross-sectional view of the operation display panel in Fig. 1.

 [Fig. 8] Fig. 8 is an outer appearance view of a transparent electrode sheet according to Embodiment 2 of the present invention.

25 [Fig. 9] Fig. 9 is an outer appearance view of a transparent electrode sheet according to a modification example in Fig. 8.

 [Fig. 10] Fig. 10 is a cross-sectional view of an operation display panel including the transparent electrode sheet in Fig. 9.

30 [Fig. 11] Fig. 11 is a cross-sectional view of an operation display panel according to Embodiment 3 of the present invention.

[Fig. 12] Fig. 12 is an exploded perspective view of an operation display panel according to Embodiment 4 of the present invention.

[Fig. 13] Fig. 13 is a detailed view of a connector connecting section of the operation display panel in Fig. 12.

5 [Fig. 14] Fig. 14 is an exploded perspective view of an operation display panel according to Embodiment 5 of the present invention.

[Fig. 15] Fig. 15 is a front view of a refrigerator according to Embodiment 5 of the present invention.

[0011]

10 Embodiment 1

Fig. 1 is a front view of a refrigerator according to Embodiment 1 of the present invention.

As illustrated in Fig. 1, a refrigerator 1 includes a refrigerator compartment 100, a versa compartment 200, an ice-making compartment 300, a freezer compartment 400, and a vegetable compartment 500. The refrigerator compartment 100 has an openable door and is disposed at the top position. The versa compartment 200 has a drawer door and is disposed at a position under the refrigerator compartment 100. The versa compartment 200 can be switched from a freezing temperature zone (-18 degrees C) to, for example, a refrigerating temperature zone (3 degrees C), a chilled temperature zone (0 degrees C), or a soft freezing temperature zone (-7 degrees C). The ice-making compartment 300 has a drawer door and is disposed in parallel to the versa compartment 200. The freezer compartment 400 has a drawer door and is disposed at a position under the versa compartment 200 and the ice-making compartment 300. The vegetable compartment 500 has a drawer door and is disposed at the bottom position.

[0012]

An operation display panel 6 is disposed on the front surface of the door of the refrigerator compartment 100. The operation display panel 6 includes operation switches that adjust the temperatures and settings of the respective compartments, display sections that display the temperature or another factor of the respective

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compartments, and other portions. The operation display panel 6 may be disposed inside the refrigerator 1, for example, on the side surface of the refrigerator compartment 100. Furthermore, the configuration of the refrigerator 1 is not limited to that illustrated in the example in Fig. 1. For example, the refrigerator 1 may not
5 include the versa compartment 200 and the ice-making compartment 300, or may have the freezer compartment 400 and the vegetable compartment 500 at positions opposite to those illustrated in Fig. 1.

[0013]

Fig. 2 is a cross-sectional side view of the refrigerator 1 in Fig. 1.

10 As illustrated in Fig. 2, the refrigerator 1 includes a compressor 2, a cooling device 3, and an air-sending fan 4. The air-sending fan 4 sends cooled air cooled by the cooling device 3 into the respective compartments of the refrigerator 1 via a flow passage 5. The flow passage 5 is provided for introducing the cooled air cooled by the cooling device 3 into the respective compartments. That is, the cooled air cooled
15 by the cooling device 3 flows through the flow passage 5 into the freezer compartment 400, the versa compartment 200, the ice-making compartment 300, and the refrigerator compartment 100 to cool these compartments. The returned cooled air from the refrigerator compartment 100 circulates through an unillustrated refrigerator compartment return flow passage to cool the vegetable compartment 500
20 and is then returned to the cooling device 3 through an unillustrated vegetable compartment return flow passage. The temperature of each compartment is detected by an unillustrated thermistor disposed in each compartment and is controlled to be a predetermined temperature by adjusting the opening degree of an unillustrated damper disposed in the flow passage 5, the performance of the
25 compressor 2, and the amount of air sent from the air-sending fan 4.

[0014]

In the freezer compartment 400, a housing case 401 is provided to store foods. In the versa compartment 200, a housing case 201 is provided to store foods. In the vegetable compartment 500, a housing case 501 is provided to store foods. Each

compartment may include one case, or alternatively, may include two or more cases to improve orderliness when the entire volume of the refrigerator 1 is large.

[0015]

Next, a configuration of the operation display panel 6 will be described.

5 Fig. 3 is an exploded perspective view of the operation display panel 6. Fig. 4 is detailed views of the operation display panel 6 in Fig. 3, and (a) illustrates a transparent electrode sheet 12 and a support member 13 and (b) illustrates the support member 13 and an electronic substrate 14. The operation display panel 6 is made up of a capacitive touch sensor that operates by detecting change in
10 capacitance. Further, the transparent electrode sheet 12 is a multilayer sheet formed of layers each having a function and corresponds to the "multilayer sheet" of the present invention.

[0016]

In Figs. 3 and 4, the operation display panel 6 is made up of roughly five
15 components that are a transparent member 11, the transparent electrode sheet 12, the support member 13 that supports the transparent electrode sheet 12, the electronic substrate 14 including a microcomputer and a light emitting source 25, and a holding member 15 that holds these components. A material of the transparent member 11 is not limited as long as the material is glass, resin, or another
20 transparent and light-transmissive material and may be provided as a designed component decorated by printing or another process as long as the material is transmissive to light emitted from the light emitting source 25. The support member 13 also functions as a light shielding wall that shields light between the adjacent icons. Further, while an inexpensive light emitting diode is often used as the light
25 emitting source 25, a light emitting source of another type may be used. The transparent member 11 forms a part of the door of the refrigerator 1 and corresponds to the "transparent plate member" of the present invention. The support member 13 supports the transparent electrode sheet 12 and corresponds to the "support member" of the present invention. The unillustrated microcomputer receives the
30 signal detected by the transparent electrode sheet 12 as an operation signal, controls

a plurality of light emitting sources 25 to emit light, and corresponds to the "controller" of the present invention.

[0017]

Next, the transparent electrode sheet 12 will be described.

Fig. 5 is an outer appearance view of the transparent electrode sheet 12, and Fig. 6 is a cross-sectional view of the transparent electrode sheet 12. Although all the display elements of the transparent electrode sheet 12 are displayed in Fig. 5, only the start button 16 is displayed in an initial state. When the start button 16 of the transparent electrode sheet 12 is touched, operation icons 17 are displayed (turned on). For convenience of illustration, Fig. 5 is illustrated with black and white inverted. The same expression applies to Figs. 8 and 9 as well.

[0018]

In the cross-sectional view of the transparent electrode sheet 12, the transparent base material 18 is located at the center, and a pattern wiring layer 19, a transparent conductive ink layer 20, and an insulating ink layer 21 are formed on the front surface (operation side) of the transparent base material 18, and an icon print layer (light shielding layer) 22, a light diffusing print layer 23, and an adhesive print layer 24 are formed on the rear surface (substrate side) of the transparent base material 18. By attaching the transparent electrode sheet 12 having the above configuration to the support member 13, the transparent electrode sheet 12 is supported by the support member 13. The transparent conductive ink layer 20 is printed at a position of the start button 16, and the transparent conductive ink layer 20, the icon print layer 22, and the light diffusing print layer 23 are printed at positions of the operation icons. The pattern wiring layer 19 is a colored wiring pattern that connects the transparent conductive ink layer 20 and the electronic substrate 14 to each other. The pattern wiring layer 19 includes a plurality of conductive wires arranged parallel to each other and corresponds to "a plurality of conductive wires" of the present invention. The transparent conductive ink layer 20 detects change in capacitance and corresponds to "a plurality of transparent conductive members" of the present invention. The icon print layer (light shielding layer) 22 has a pattern for

displaying a plurality of shapes, such as characters and symbols (see Fig. 5), and corresponds to the "light shielding layer" of the present invention. The light diffusing print layer 23 diffuses light emitted from the light emitting source 25 and corresponds to the "light diffusing layer" of the present invention.

5 [0019]

Fig. 7 is a cross-sectional view of the operation display panel 6 and illustrates all components of the operation display panel 6.

When the operation icon 17 is displayed (turned on), the light emitting source 25 emits light through the transparent conductive ink layer 20, the icon print layer 22, the light diffusing print layer 23, and the transparent member 11 to display the icon to be observable. Further, when the operation icon 17 is touched, operation is activated. The light emitting source 25 is disposed for each of the start button 16, the operation icons 17, and letters (characters) on the icon print layer 22, and the light diffusing print layer 23 is also configured to enable surface emission for each of the icons or characters.

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[0020]

The light diffusing print layer 23 is printed on the transparent electrode sheet 12 to diffuse light emitted by the light emitting sources 25, thereby enabling surface emission. Consequently, large icons or characters can be displayed with uniform light without using a member such as a light guide.

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[0021]

Furthermore, by using a white or similar color support member 13, reflected light from the light emitting sources 25 can be effectively used for the icons, thereby improving visibility. In this case, when a transparent member is used instead of the white or similar colored member, light from the light emitting source 25 may be partially transmitted through the support member 13 and the adjacent icons may be erroneously illuminated. To prevent transmission of light to the adjacent icons, a double wall 26 may be formed on the support member 13. The double wall 26 corresponds to the "light shielding wall" of the present invention.

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[0022]

As described in Embodiment 1, the transparent conductive ink layer 20 that detects change in capacitance, the pattern wiring layer 19 that transmits the change in capacitance to the electronic substrate 14, the icon print layer 22 that uses light emitted by the light emitting source 25 to display the icon, and the light diffusing print layer 23 that uses light to enable surface emission are collectively printed on a single transparent base material (film base material) 18 as illustrated in the cross-sectional view of the transparent electrode sheet 12 in Fig. 6, thereby significantly reducing the number of components than that of the related art. As a result, reducing the number of components can improve productivity, reduce costs, and ensure consistent quality.

[0023]

Moreover, since the icons and letters (characters) are displayed by the light emitting source 25 emitting light through the transparent member 11, the operation display panel 6 provides good visibility and usability for users of all ages. In addition, the shapes of the transparent electrode sheet 12 and the support member 13 have been devised so that surface emission equal to or more than that using the light guide can be achieved, enabling improved visibility without increasing the number of components. The transparent member 11 may also be provided as a decorated designed component that forms a part of the door of the refrigerator 1.

[0024]

Embodiment 2

Fig. 8 is an outer appearance view of a transparent electrode sheet 12 according to Embodiment 2 of the present invention.

Although the pattern wiring layer 19 may have various wiring patterns, the wiring for the start button 16 will be described as an example. When the wiring of the start button 16 is patterned like a single wire 27, the start button 16 may react when the wiring region is touched by a finger, leading to an erroneous operation. Because the single wire decreases stray capacitance, the wiring region as well as the transparent conductive ink layer 20 becomes highly sensitive and may cause the start button 16 to react.

[0025]

In Embodiment 2, as illustrated in Fig. 8, a complex wire 28 is collected on one side together with another pattern wiring group 29 made up of a plurality of parallel wires collected together in parallel. As a result, the stray capacity of the wiring region of the start button 16 is less sensitive than that of the single wire, thereby preventing erroneous operation of the start button 16. Thus, erroneous operation of the buttons can be prevented by collecting the wiring groups together. This wiring configuration may also be applied to operation buttons other than the start button 16.

[0026]

Fig. 9 is a view of a modification example of a transparent electrode sheet in Fig. 8, and Fig. 10 is a cross-sectional view of the operation display panel 6 including the transparent electrode sheet 12 in Fig. 9.

As illustrated in Fig. 9, a part of the transparent electrode sheet 12 (and the transparent base material 18) is extended to the left side. Then, the single wire 27 of the start button 16 is laid on the extended portion. Furthermore, as illustrated in Fig. 10, the extended portion of the transparent electrode sheet 12 is curved along the support member 13 to be attached to the support member 13 and thereby provides an air gap 30 between the transparent member 11 and the transparent electrode sheet 12. With this configuration, change in capacitance can be eliminated even when a finger touches the transparent member 11 including the wiring region (in particular, the single wire 27). As described, providing the air gap 30 can prevent erroneous operation.

[0027]

Furthermore, in the example in Fig. 10, a spigot structure 31 is formed in the holding member 15 so that a part of the transparent electrode sheet 12 is curved and housed in the spigot structure 31. Because the transparent electrode sheet 12 is curved to be attached to the support member 13. The transparent electrode sheet 12 may peel when an adhesive force is reduced. However, even when the transparent electrode sheet 12 peels, the spigot structure 31 holds the transparent electrode sheet 12 as is curved, and thus maintains the air gap 30.

[0028]

In addition, because the air gap 30 may be effectively provided at any position in the wiring region to prevent erroneous operation, the air gap 30 can be provided at an appropriate position depending on the peripheral structure and icon arrangement. For example, the air gap 30 may be provided at a portion of the complex wire 28.

5 [0029]

Embodiment 3

Next, an example having improved visibility in the surface emission will be described in Embodiment 3.

Fig. 11 is a cross-sectional view of an operation display panel 6 according to Embodiment 3 of the present invention.

As illustrated in Fig. 11, light shielding walls 13a are formed to shield light from the light emitting source 25 adjacent to the support member 13, and tapered surfaces 32 are formed on the light shielding walls 13a. By providing such light shielding walls 13a, a light guiding region formed between the adjacent light shielding walls 13a has a tapered surface. As a result, light emitted from the light emitting source 25 is not shielded and can be transferred to the icon print layer 22 of the transparent electrode sheet 12.

15 [0030]

The tapered surface 32 preferably has an angle larger than an irradiation area 33 of the light emitting source 25 but the angle may be structurally restricted. The angle may not always be larger than the irradiation area 33, and other angles can also improve the visibility.

20 [0031]

Furthermore, similarly to Embodiment 1, when a white or similar colored member is used for the support member 13 (light shielding wall 13a), a reflected light from the light emitting sources 25 can be effectively used for the icon print layer 22, thereby improving visibility.

25 [0032]

Embodiment 4

Fig. 12 is an exploded perspective view of an operation display panel according to Embodiment 4 of the present invention, and Fig. 13 is a detailed view of a connector connecting section in Fig. 12.

As illustrated in Figs. 12 and 13, the support member 13 has a partition plate 34, and the electronic substrate 14 includes a transparent electrode sheet connector 35 and a main body lead wire connector 36. The transparent electrode sheet connecting section 37 is formed as a part of the transparent electrode sheet 12 in a strip shape that is continuous from the complex wire 28 in Fig. 8. The transparent electrode sheet connecting section 37 is connected to the transparent electrode sheet connector 35 through an opening 13b formed in the support member 13.

Furthermore, the main body lead wire 38 that is routed from the door of the refrigerator 1 is connected to the main body lead wire connector 36. When electric current flows to the main body lead wire 38 in a state in which the transparent electrode sheet connecting section 37 and the main body lead wire 38 are in close contact with each other, induced current flows to the transparent electrode sheet connecting section 37, which may cause erroneous operation of the operation display panel 6 when the operation icons 17 are not operated. To prevent this problem, the support member 13 includes the partition plate 34 to prevent close contact between the transparent electrode sheet connecting section 37 and the main body lead wire 38. That is, the partition plate 34 separates the transparent electrode sheet connecting section 37 from the main body lead wire 38, thereby protecting the transparent electrode sheet connecting section 37. As a result, an unintended operation of the operation display panel 6 can be prevented. In addition, the transparent electrode sheet connecting section 37 corresponds to "a strip-shaped section on which a plurality of conductive wires are formed" in the transparent electrode sheet 12 according to the present invention.

[0033]

Embodiment 5

Fig. 14 is an exploded perspective view of an operation display panel according to Embodiment 5 of the present invention and illustrates the entire components of the

operation display panel, and Fig. 15 is a front view of the refrigerator in which the operation display panel in Fig. 14 is mounted. In Figs. 14 and 15, elements assigned with the same reference signs as those in Figs. 3 and 1 refer to the same or corresponding elements.

The operation display panel 6 is made up of roughly six components, which are the transparent member 11, the transparent electrode sheet 12, the light guiding member 41, an outer shell member 42, the electronic substrate 14 and the holding member 15. In Embodiment 5, the light guiding member 41 and the outer shell member 42 serve to perform the function of the support member 13 in Fig. 3. The light guiding member 41 guides the light from the light emitting source 25 to the transparent electrode sheet 12, and the outer casing shell 42 supports the light guiding member 41.

[0034]

The operation display panel 6 has the above configuration, and thus the transparent electrode sheet 12 and the electronic substrate 14 can be connected by a connector after the transparent electrode sheet 12 is attached to the outer shell member 42, and then, the light guiding member 41 can be incorporated. Consequently, the transparent electrode sheet 12 attached to the outer shell member 42 is connected to the electronic substrate 14 by the connector, thereby improving workability and increasing productivity.

Reference Signs List

[0035]

1	refrigerator	2	compressor	3	cooling device	4	air-
	sending fan	5	flow passage	6	operation display panel	11	
25	transparent member	12	transparent electrode sheet	13	support		
	member	13a	light shielding wall	13b	opening	14	electronic substrate
	15	holding member	16	start button	17	operation icon	18
	transparent base material	19	pattern wiring layer	20	transparent		
	conductive ink layer	21	insulating ink layer	22	icon print layer (light		
30	shielding layer)	23	light diffusing print layer	24	adhesive print layer	25	

light emitting source 26 double wall 27 single wire 28 complex
 wire 29 another pattern wiring group 30 air gap 31 spigot structure
 32 tapered surface 33 irradiation area 34 partition plate 35
 transparent electrode sheet connector 36 main body lead wire connector 37
 5 transparent electrode sheet connecting section 38 main body lead wire
 41 light guiding member 42 outer shell member 100
 refrigerator compartment 200 versa compartment 300 ice-making
 compartment 400 freezer compartment 500 vegetable compartment
 201 versa compartment housing case 301 ice-making compartment
 10 housing case 401 freezer compartment housing case 501 vegetable
 compartment housing case

CLAIMS

[Claim 1]

A refrigerator comprising an operation display,
the operation display including
a transparent plate member,
a multilayer sheet disposed on a rear side of the transparent plate member and
configured to detect at least change in capacitance, and
an electronic substrate disposed on a side of the multilayer sheet opposite to
the transparent plate member, the electronic substrate including a plurality of light
emitting sources configured to emit light toward the multilayer sheet, and including a
controller configured to receive a signal detected by the multilayer sheet as an
operation signal and control the plurality of light emitting sources to emit light,
the multilayer sheet including
a transparent base material,
a plurality of transparent conductive members disposed on a surface of the
transparent base material facing the transparent plate member and configured to
detect change in capacitance,
a light shielding layer disposed on a surface of the transparent base material
on a side of the electronic substrate and includes a pattern configured to display a
shape of at least one of characters and symbols, and
a light diffusing layer disposed on a surface of the light shielding layer on a side
of the electronic substrate and configured to diffuse light emitted from the plurality of
light emitting sources,
the light shielding layer, the light diffusing layer, and the plurality of transparent
conductive members being printed on the same transparent base material.

[Claim 2]

The refrigerator of claim 1, further comprising a shielding wall disposed
between the plurality of light emitting sources.

[Claim 3]

The refrigerator of claim 1 or 2, wherein
the multilayer sheet further includes a plurality of conductive wires configured to transmit a signal detected by the plurality of transparent conductive members to the electronic substrate, and
the plurality of conductive wires are arranged parallel to each other.

[Claim 4]

The refrigerator of claim 3, wherein a gap is provided between the transparent plate member and a portion in which the plurality of conductive wires of the multilayer sheet are disposed.

[Claim 5]

The refrigerator of claim 2, or claim 3 or 4 as dependent on claim 2, wherein the shielding wall has a white wall surface.

[Claim 6]

The refrigerator of claim 2 or any one of claims 3 to 5 as dependent on claim 2, wherein the shielding wall is inclined to increase an opening extending from at least one of the plurality of light emitting sources to the transparent plate member.

[Claim 7]

The refrigerator of claim 6, further comprising a support member disposed between the multilayer sheet and the electronic substrate and configured to support the multilayer sheet, wherein
the shielding wall is formed on the support member.

[Claim 8]

The refrigerator of claim 7, wherein

the multilayer sheet includes a strip-shaped section on which a plurality of conductive wires are formed to be connected to the electronic substrate, and

the support member includes a partition plate disposed in a connecting portion between the strip-shaped section and the electronic substrate to protect the strip-shaped section.

[Claim 9]

The refrigerator of claim 7 or 8, wherein the support member includes a light guiding member configured to guide light from the plurality of light emitting sources to the multilayer sheet and an outer shell member configured to support the light guiding member.