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(54) FRIDGE-FREEZER

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(57) **ABSTRACT**

A fridge-freezer equipped with a deodorizing unit which has a filter including photocatalyst and a light emitting unit including an LED as a light source mounted on a substrate. The fridge-freezer is designed to solve problems posed by conventional fridge-freezers. One of the problems is that in the case of using a glass-tube type lamp such as a black light or a cold cathode tube as the light source, the light source becomes large in size which requires a large space for installation. This does not allow the deodorizing unit to be installed in the compartments in the refrigerator. Another problem is that the deodorizing unit was not designed to be safe for food in case that part of the deodorizing unit is damaged to give harmful damage to food.

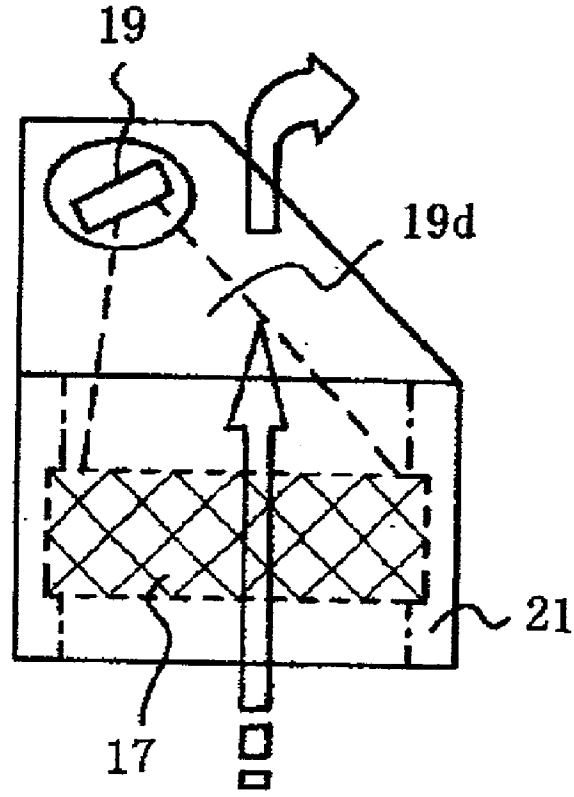


Fig. 1

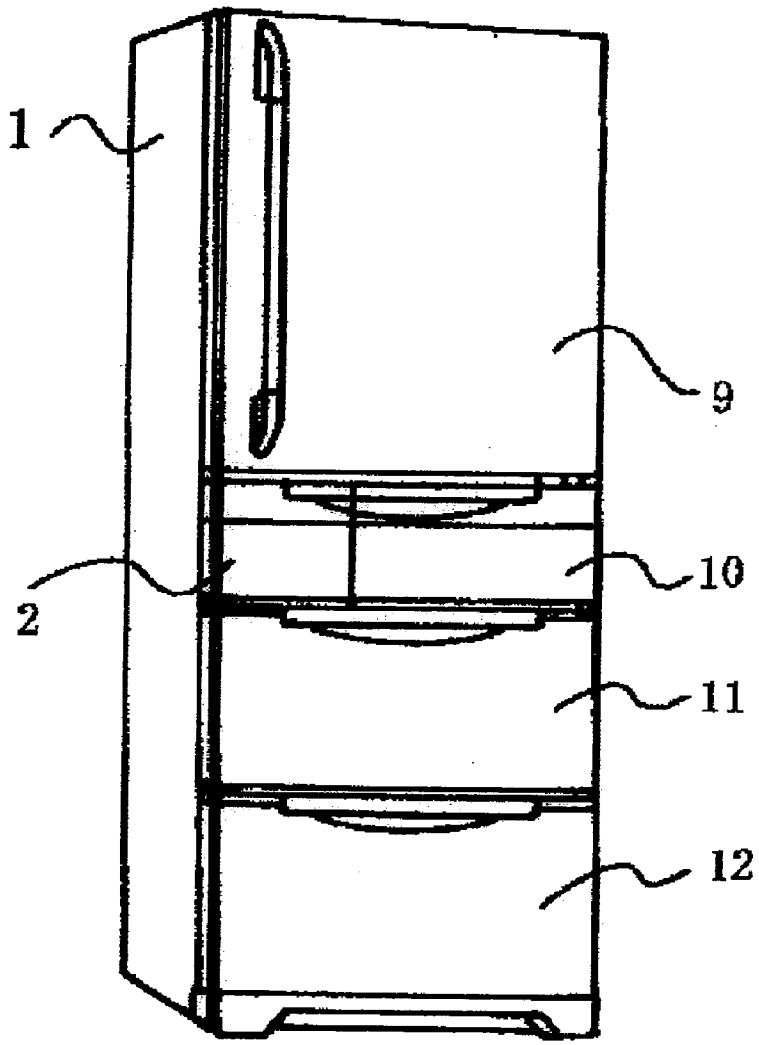


Fig. 2

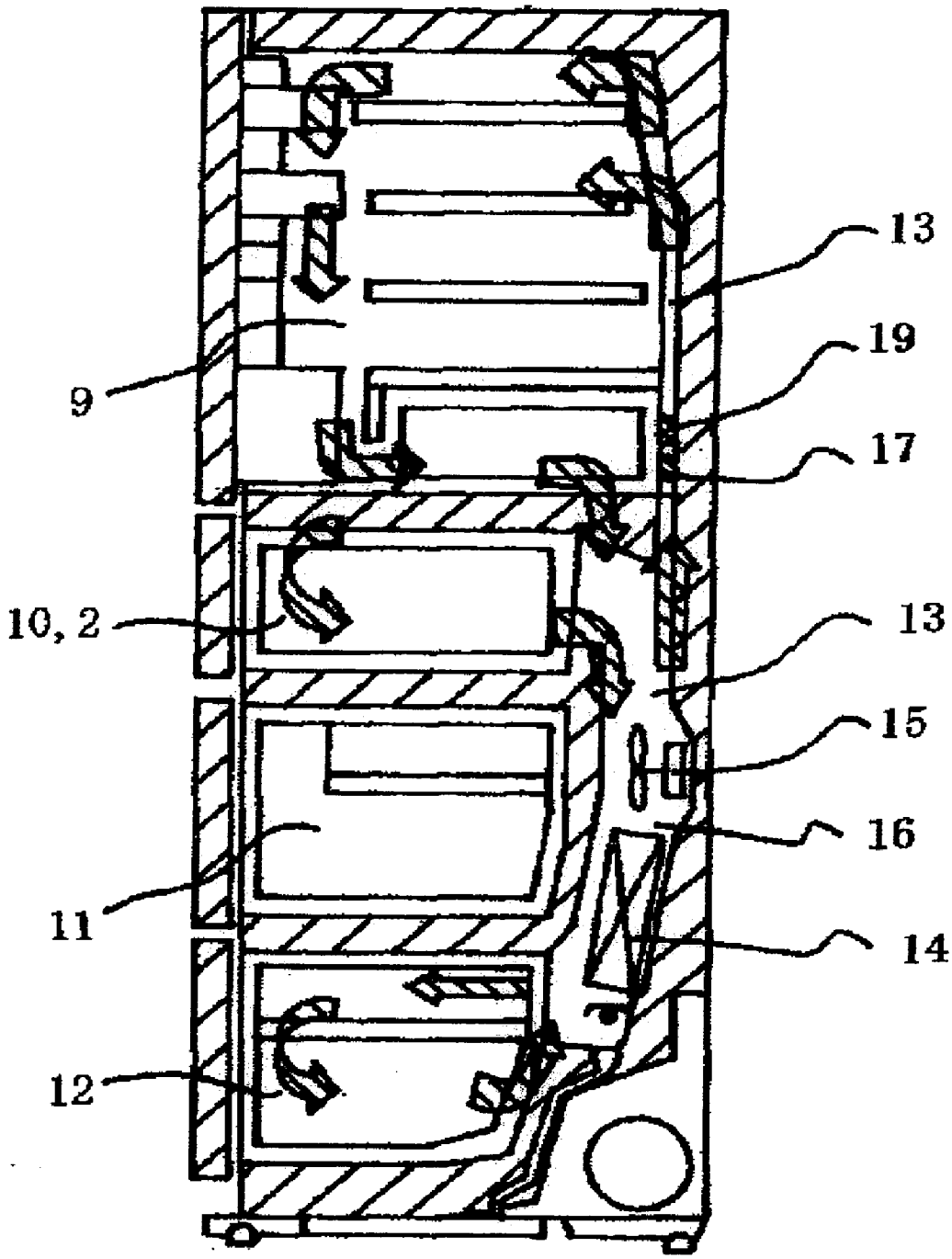


Fig. 3

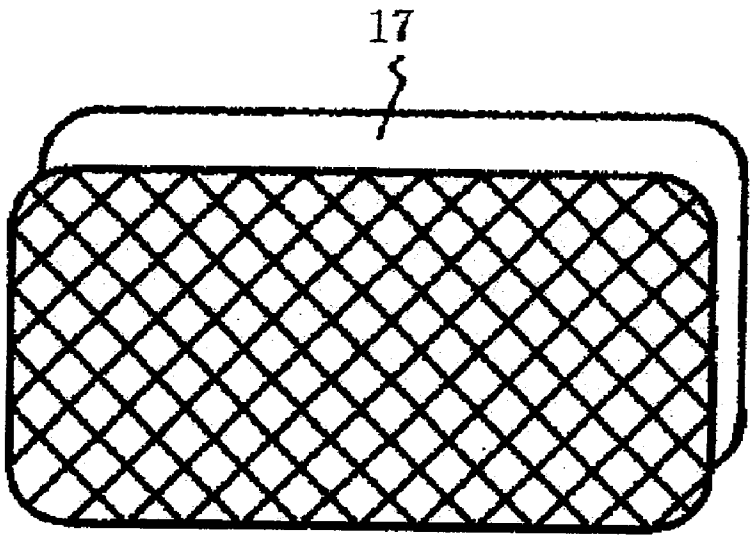


Fig. 4

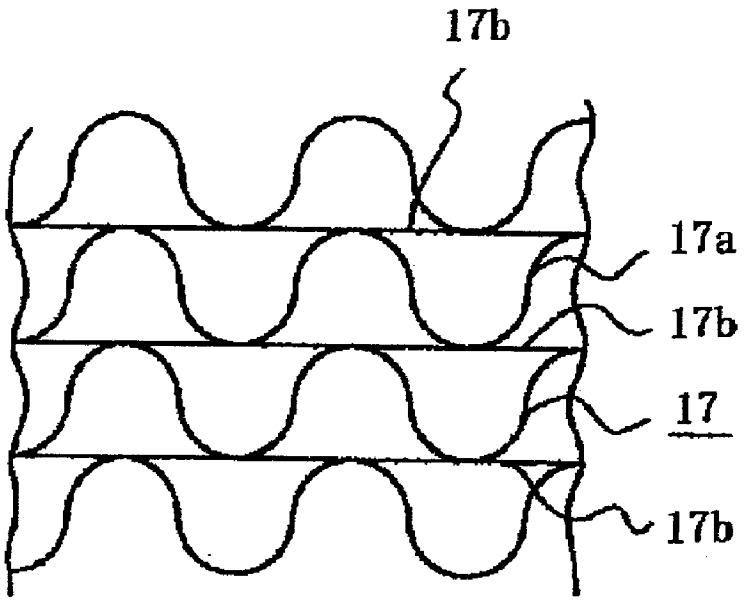


Fig. 5(a)

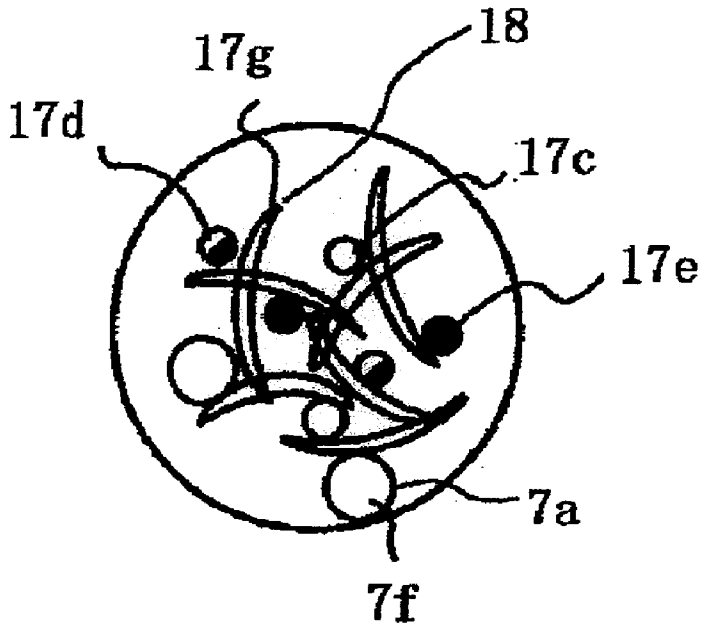


Fig. 5(b)

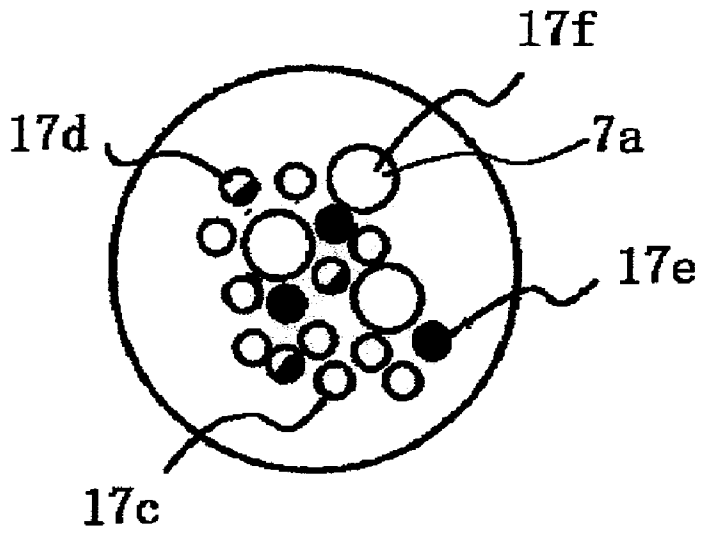


Fig. 6

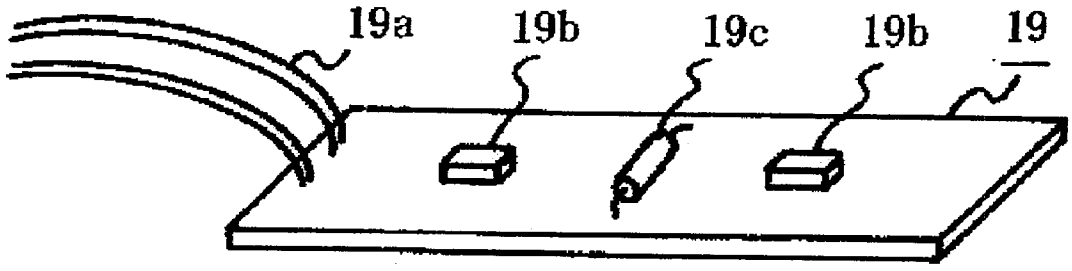


Fig. 7

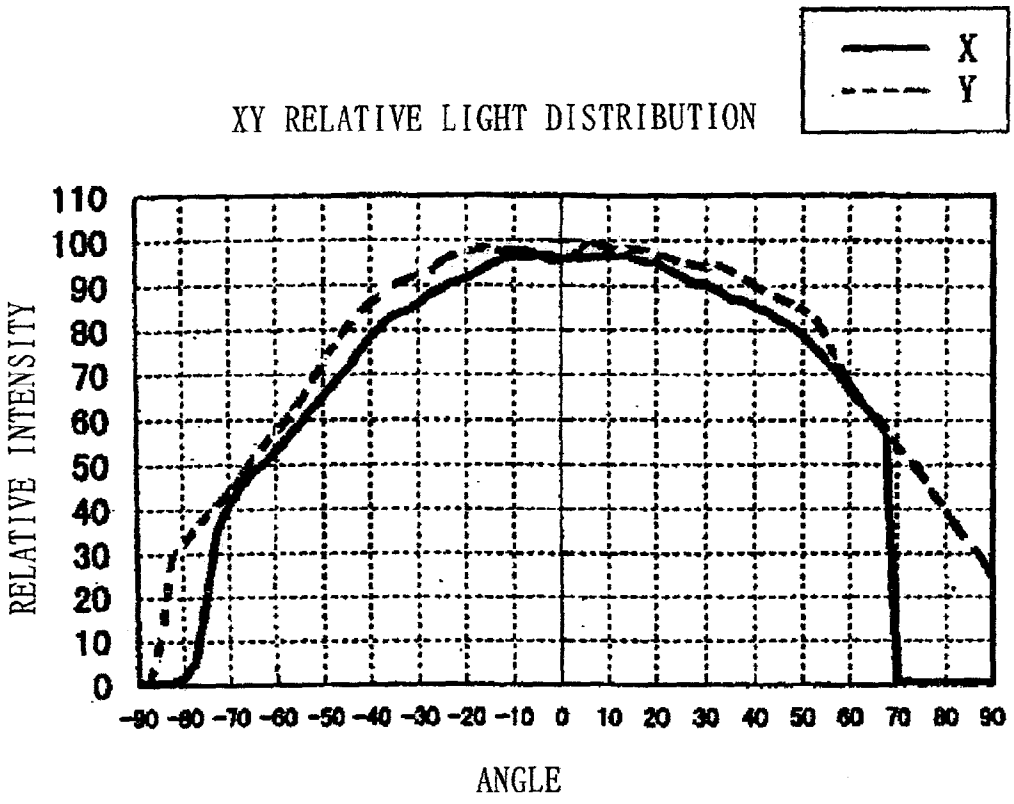

X
Y
XY RELATIVE LIGHT DISTRIBUTION
RELATIVE INTENSITY
110
100
90
80
70
60
50
40
30
20
10
0
-90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90
ANGLE

Fig. 8

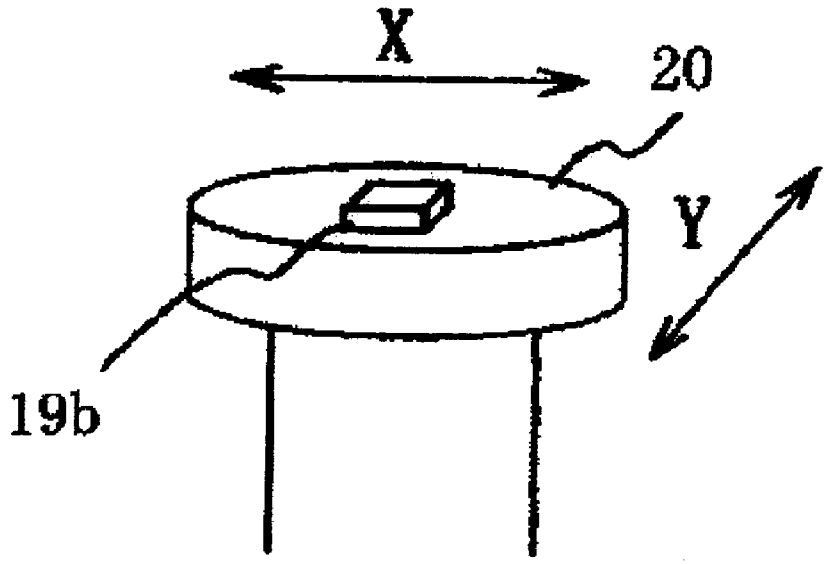


Fig. 9

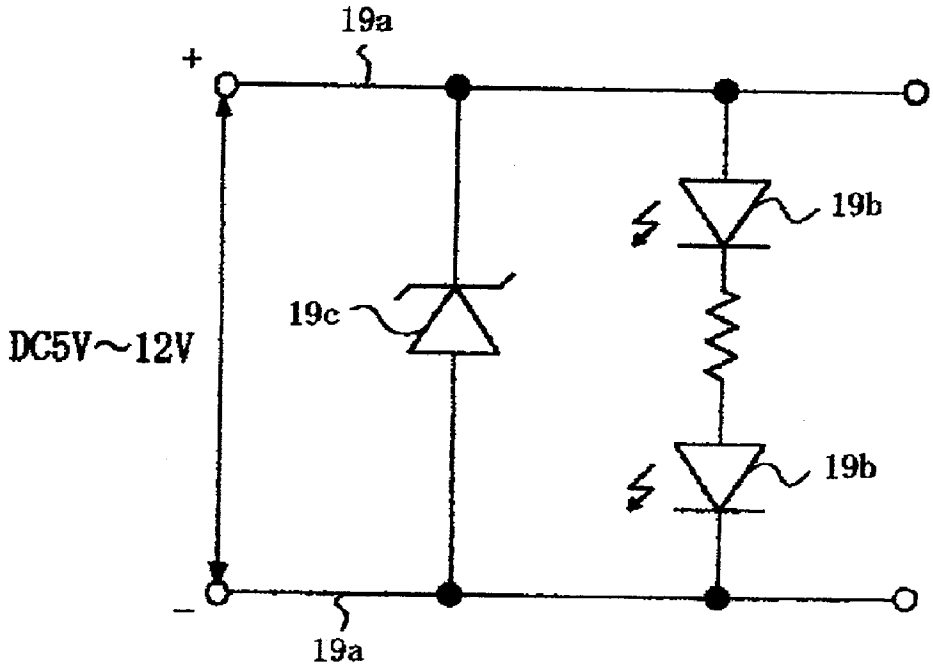


Fig.10

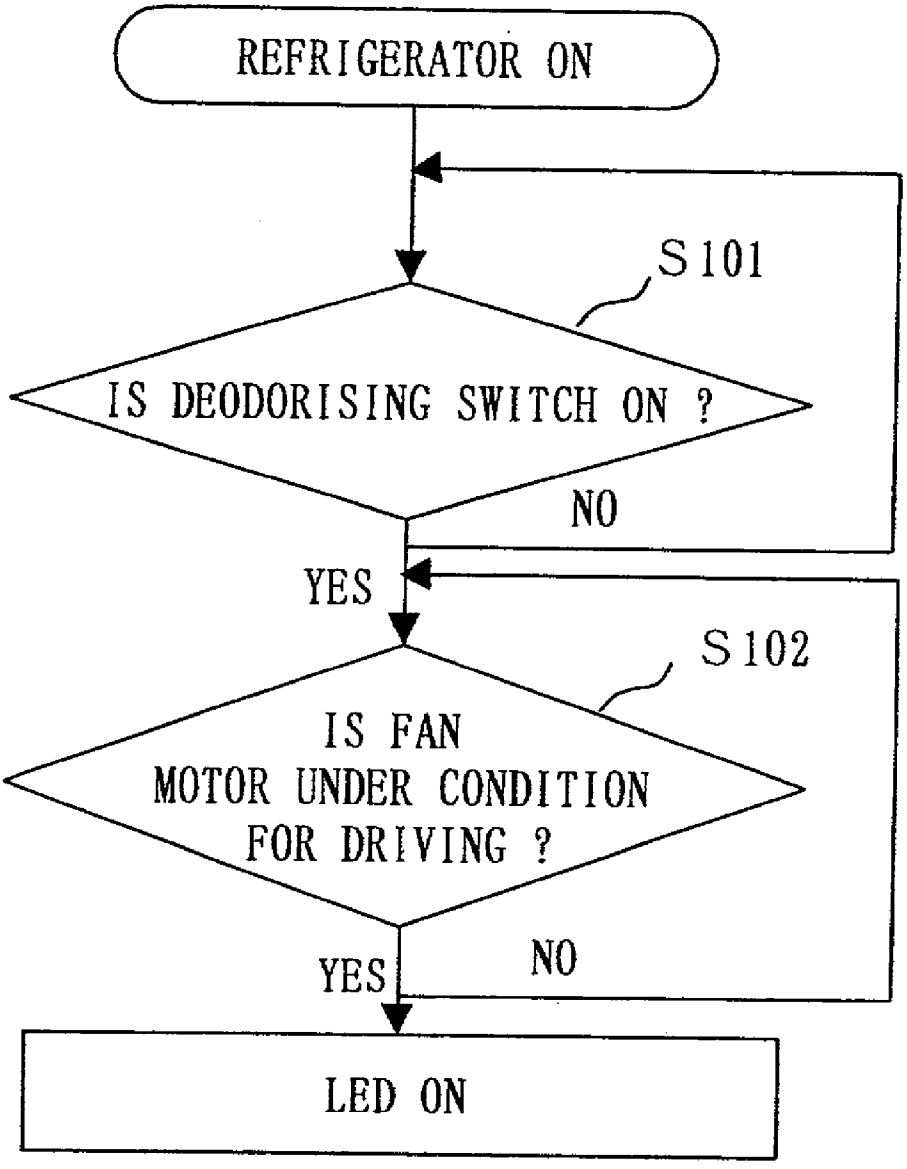

REFRIGERATOR ON
S101
IS DEODORISING SWITCH ON ?
NO
YES
S102
IS FAN MOTOR UNDER CONDITION FOR DRIVING ?
YES
NO
LED ON

Fig.11

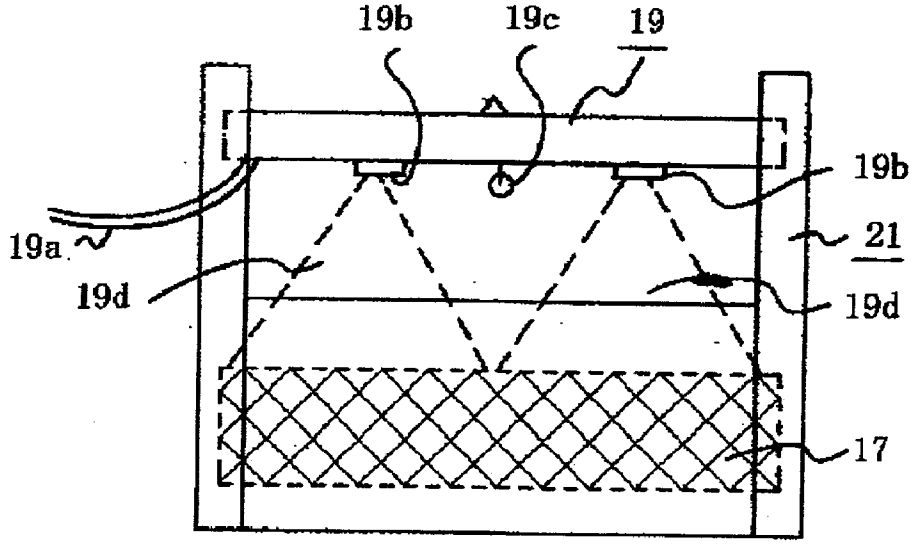


Fig. 12

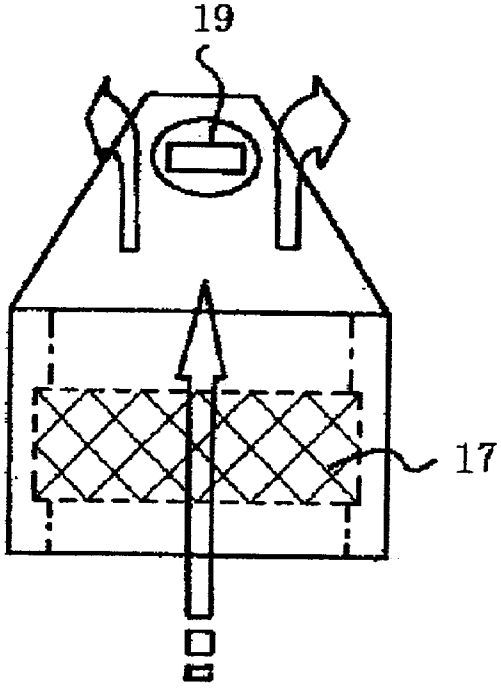


Fig.13

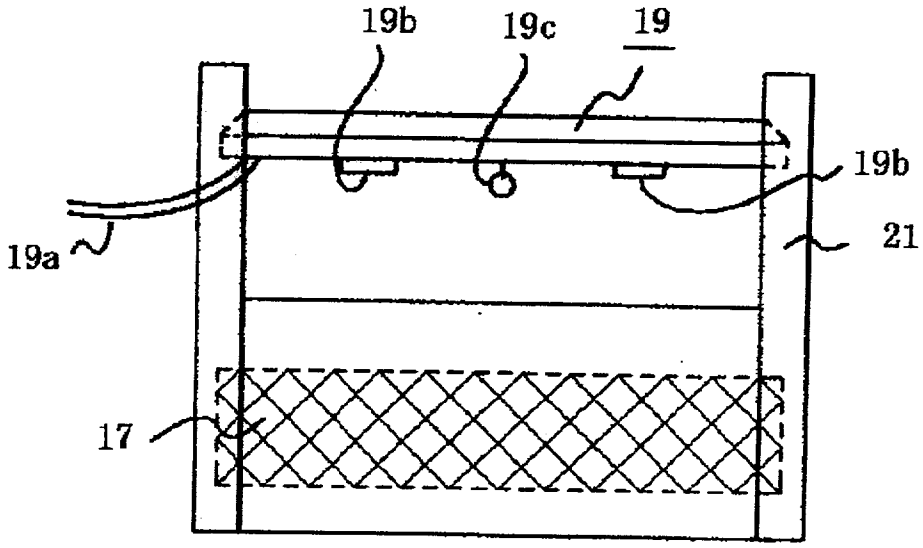


Fig. 14

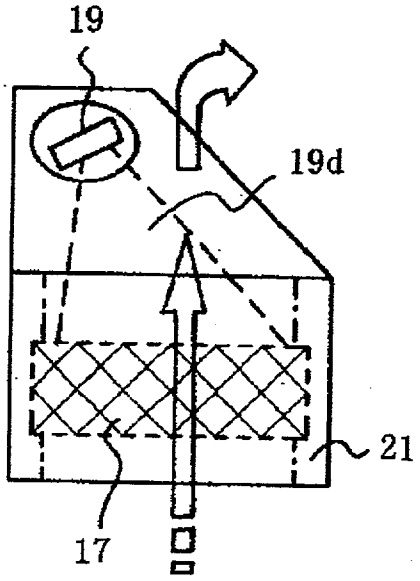


Fig.15

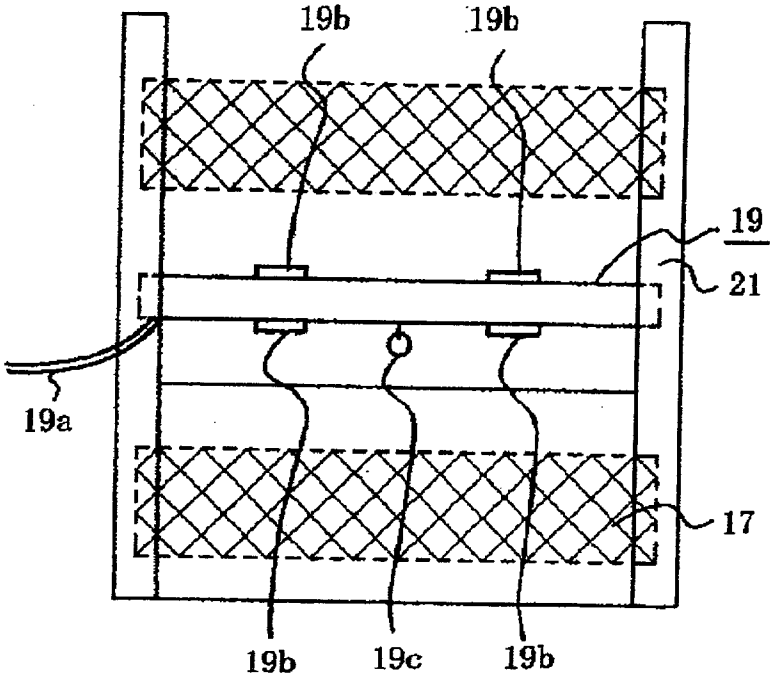


Fig. 16

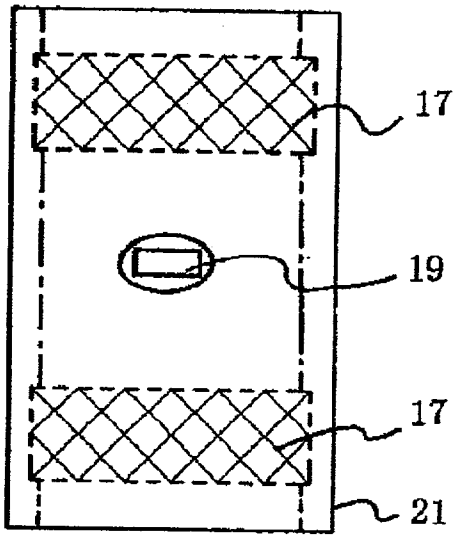


Fig.17

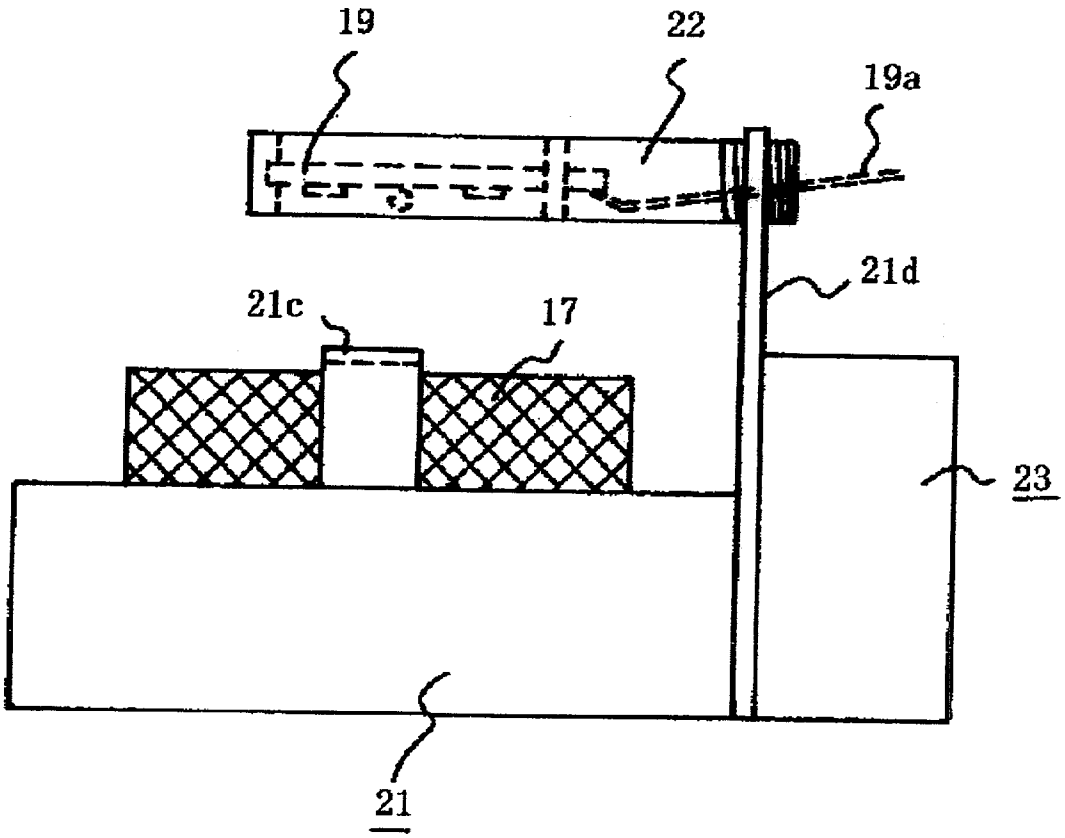


Fig.18

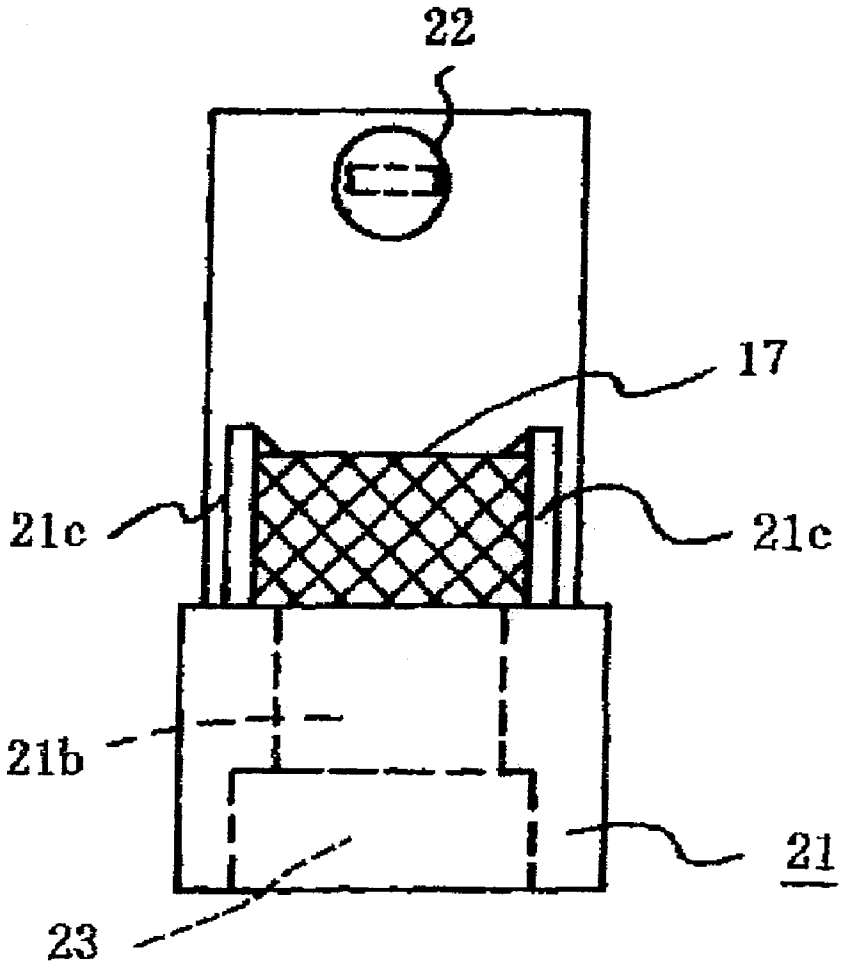


Fig.19

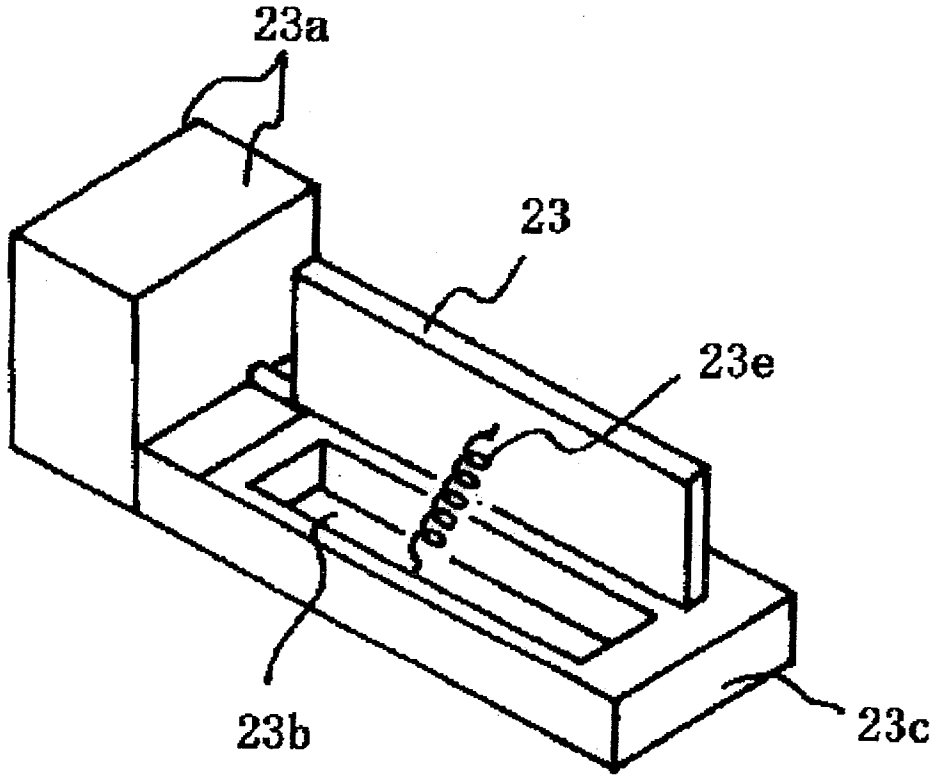


Fig.20

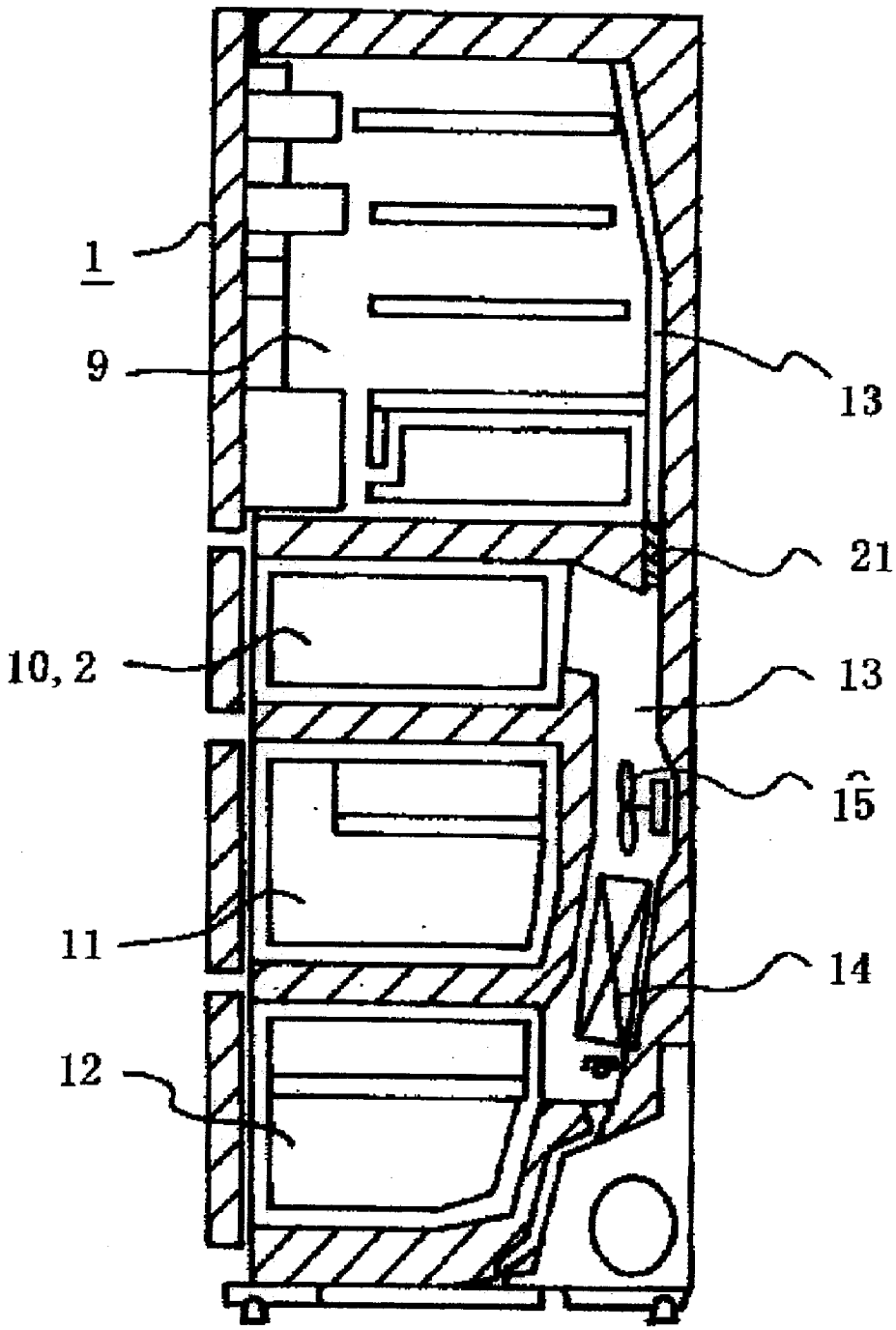


Fig.21

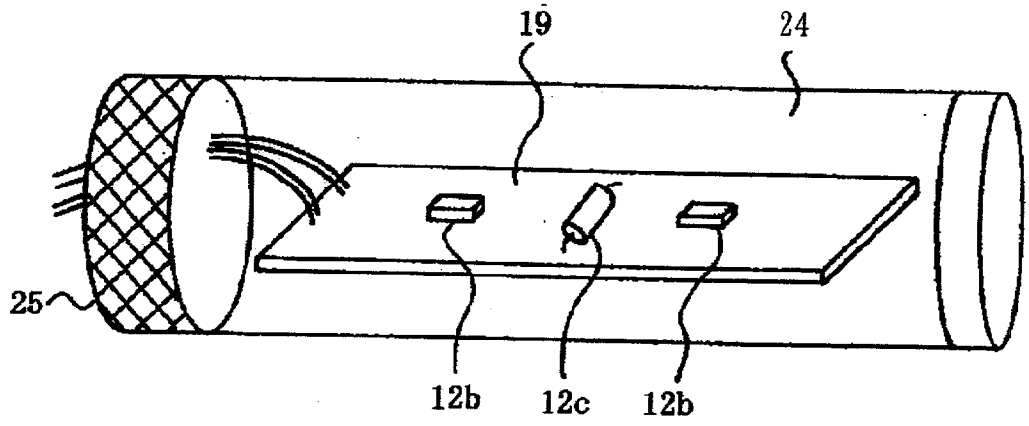


Fig.22

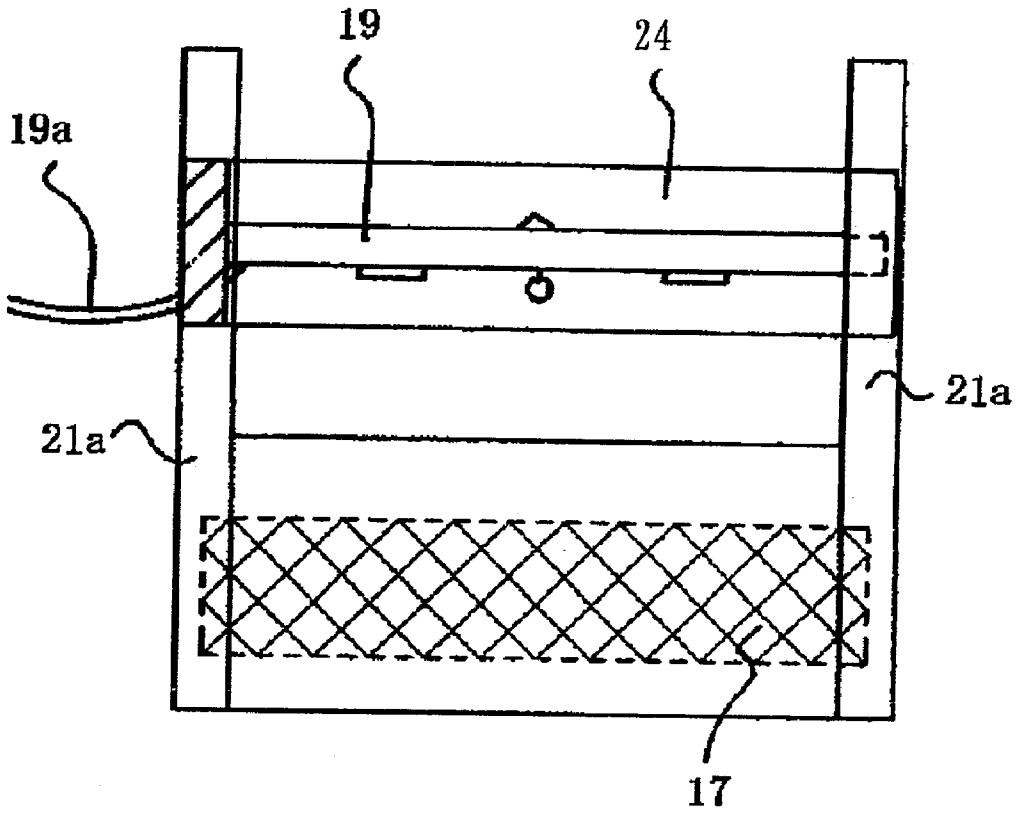


Fig.23

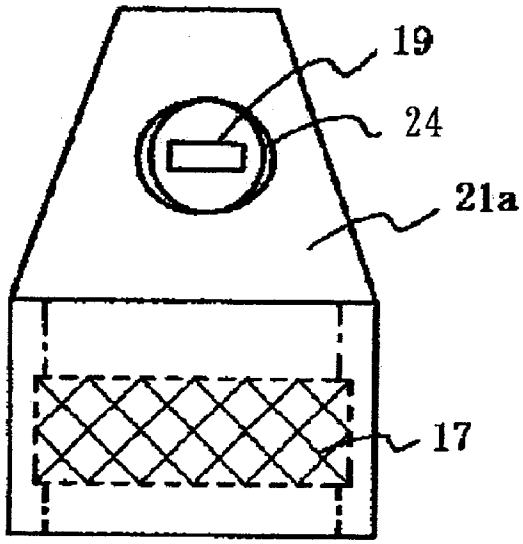


Fig. 24

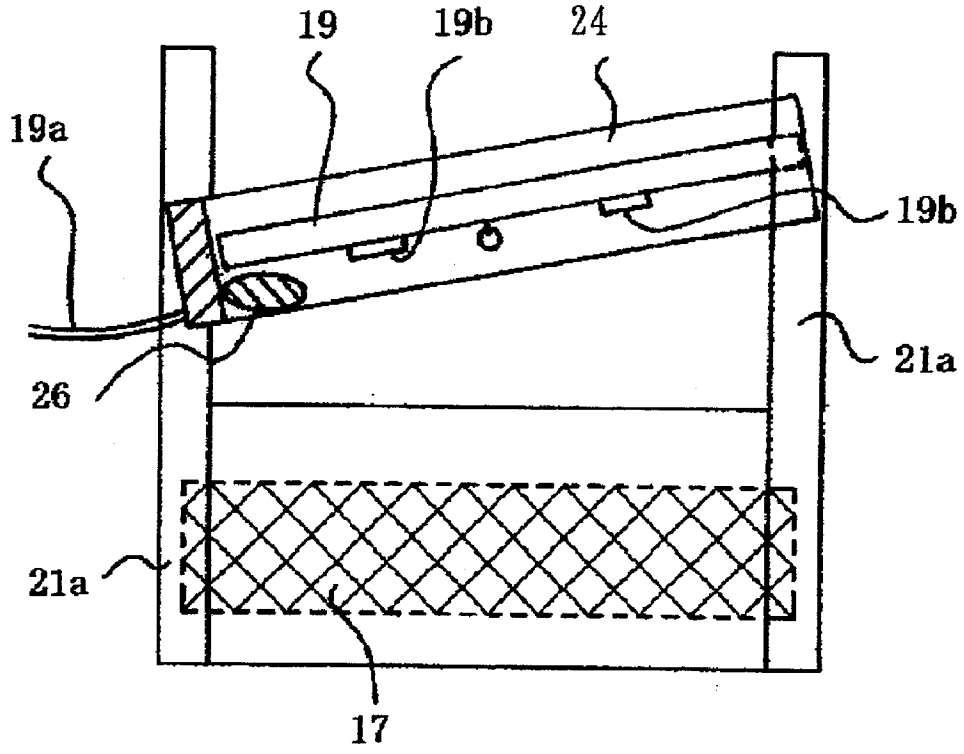


Fig.25

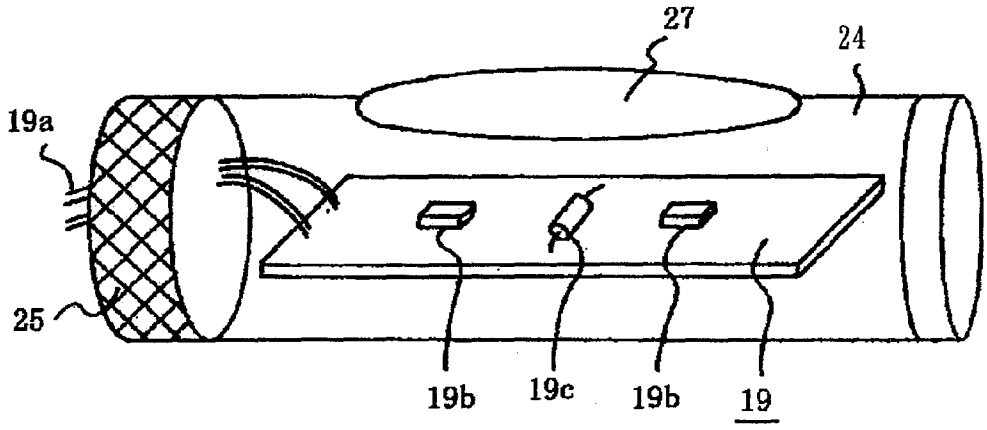

27
24
19a
25
19b
19c
19b
19

Fig. 26

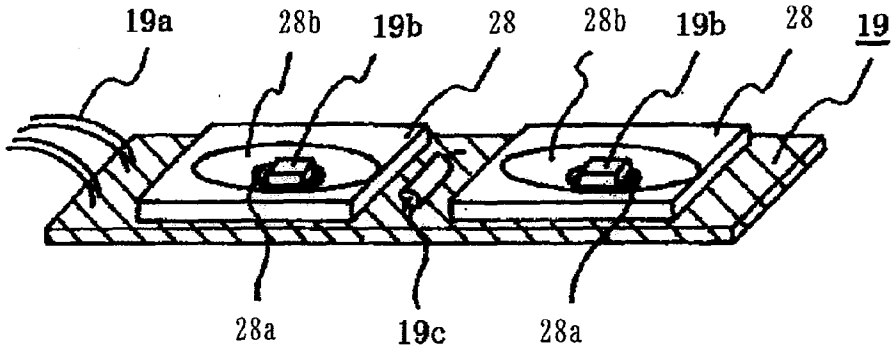

19a
28b
19b
28
28b
19b
28
19
28a
19c
28a

Fig.27

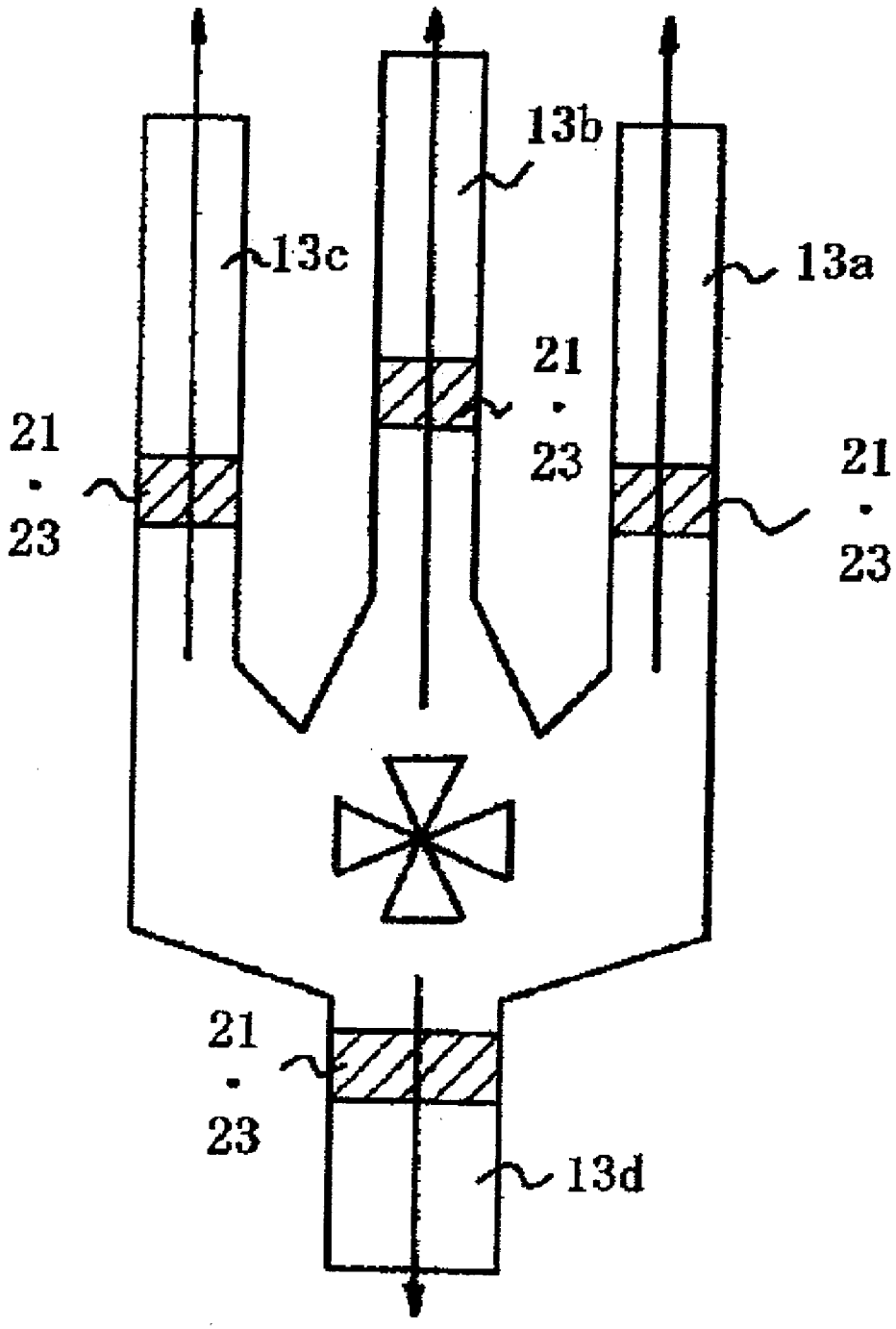


Fig. 28

CONVENTIONAL ART

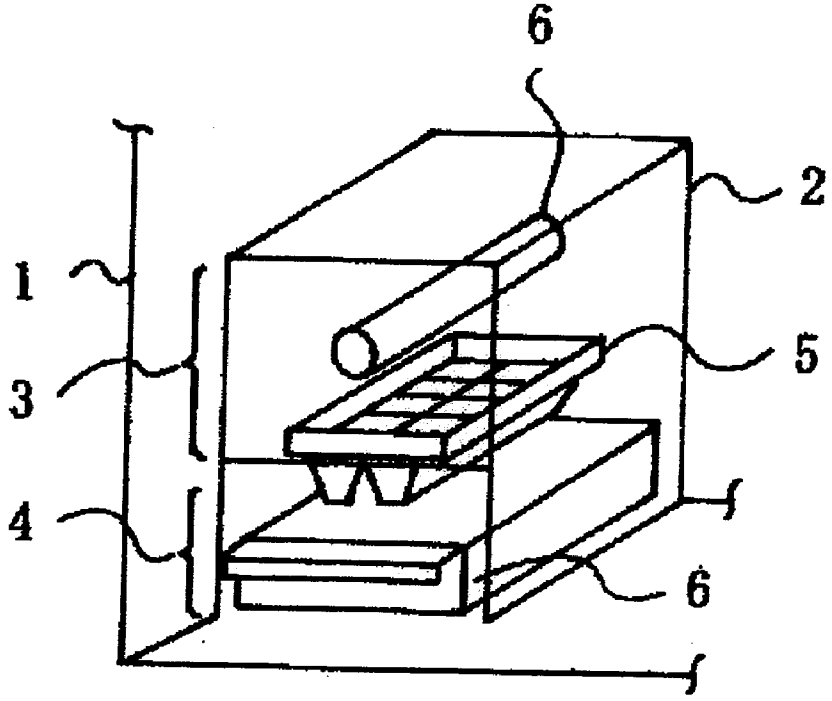


Fig. 29

CONVENTIONAL ART

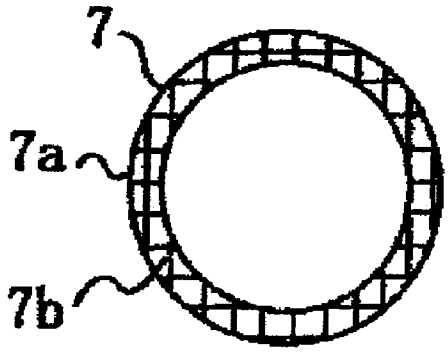


Fig. 30

CONVENTIONAL ART

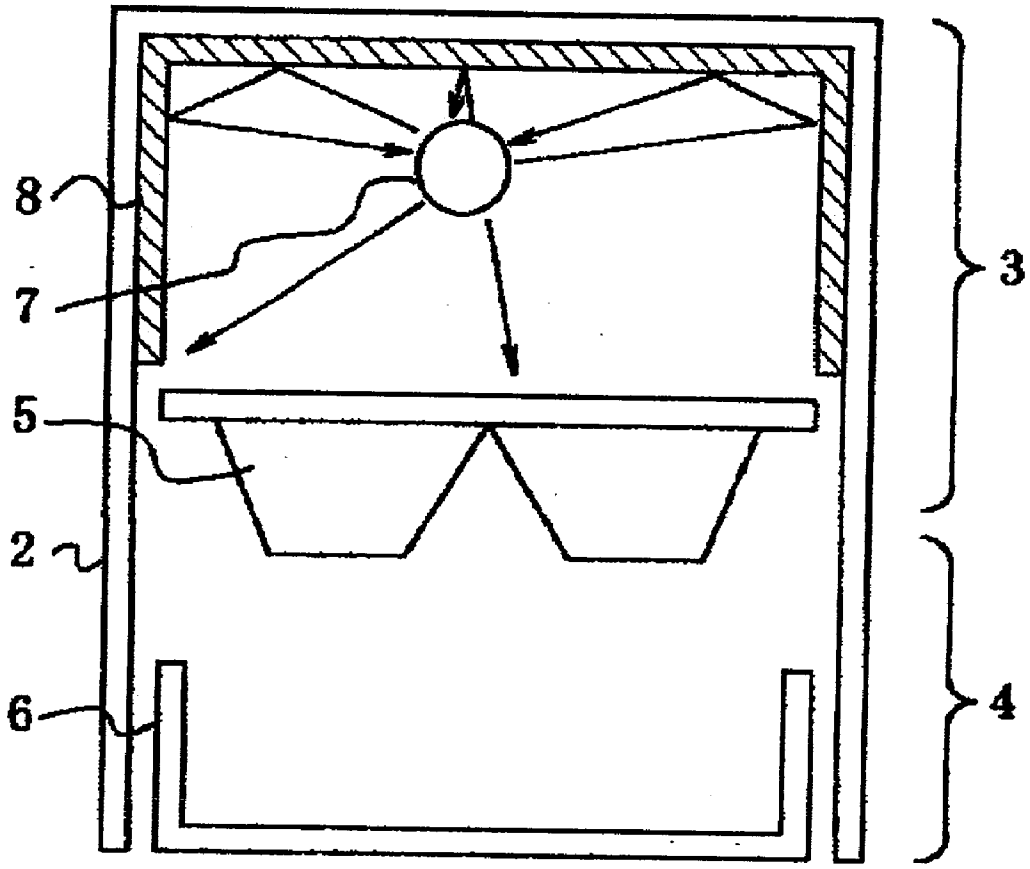
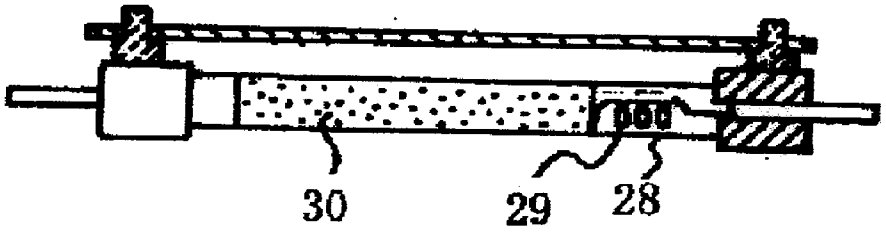


Fig. 31

CONVENTIONAL ART



FRIDGE-FREEZER

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a fridge-freezer, and more particularly to a fridge-freezer equipped with a deodorizing unit for deodorizing the inside of the fridge-freezer.

[0003] 2. Description of the Related Art

[0004] **FIG. 28** is a perspective view of a fridge-freezer disclosed in Unexamined Patent Publication No. 2000-249460, for example, illustrating a relevant part only. **FIG. 29** is a sectional view of a photocatalyst means. **FIG. 30** is a sectional view of the ice-maker of the fridge-freezer. With referring to the figures, a reference numeral **1** denotes the body of the fridge-freezer. A reference numeral **2** denotes a box-type ice-maker provided in the body. In an upper part of the ice-maker **2**, an ice-making unit **3** for making ice is provided. In a lower part of the ice-maker **2**, an ice keeping unit **4** for keeping ice made by the ice making unit **3** is provided. In the ice-making unit **3**, an ice tray **5** is placed with hollows in a given shape for holding water. In the ice keeping unit **4**, an ice box **6** is placed with an open top so as to catch ice cubes made by the ice tray **5**. Then, a photocatalyst means **7** is provided above the ice tray **5**.

[0005] The photocatalyst means **7** is obtained by coating a photocatalyst **7***b* such as titanium (Tio_2) transparently or translucently on the surface of a light-irradiating tube **7***a* by means of such as a sol-gel process or a fine-grain suspension as shown in **FIG. 29**. As an irradiation light, ultraviolet rays are considered effective. Therefore, it is desirable to use a black light for the photo-irradiating tube **7***a* of the photocatalyst means **7**.

[0006] Alternatively, as shown in **FIG. 30, a** light-reflecting material **8** such as mirror or metal may be fitted on the inner surfaces of the ice-making unit **3**. The light-reflecting material **8** may also be obtained through a metal plating process. With the light-reflecting material **8** being provided, reflected light of light emitted by the photocatalyst means **7** is concentrated by the photocatalyst means **7**. As a result, an irradiation amount of the photocatalyst is increased, and therefore a decomposition reaction may be facilitated further.

[0007] **FIG. 31** shows a part of an embodiment disclosed in Unexamined Patent Publication No. Hei9-61042, for example. The figure shows the configuration of a glass-tube heater for defrosting. A reference numeral **28** denotes a glass-tube, a reference numeral **29** denotes a heater wire, and a reference numeral **30** denotes a deodorization coating material. This heater is installed in a lower part of a cooling unit, as shown in the figure, for the purpose of defrosting the cooling unit.

[0008] According to the conventional fridge-freezer, in the case of using a glass-tube lamp such as a black light or a cold cathode, for example, as the light source as mentioned above, the light source becomes bigger. However, an allotted space for installing the deodorizing unit is limited. As a result, the deodorizing means is not allowed to be installed in other compartments in the refrigerator than the ice-maker. This has posed a problem.

[0009] Further, the light source is formed by a glass tube. Therefore, the light source should be treated with meticulous care so as not to break it, and designed to be away from any stress to be exerted on the glass tube after installation. Especially with a fluorescent light being used as the light source, because a fluorescent light uses mercury inside, it is not desirable to use a fluorescent light near food in the refrigerator assuming that the fluorescent light is damaged. This has posed a problem.

[0010] Furthermore, many refrigerators use AC100V as an input voltage. Hence, there is a fear of causing a critical problem if such as a fault occurred in a refrigerator using an alternate refrigerant such as HC.

[0011] Still further, in the case that a deodorizing substance is coated on the glass-tube heater for defrosting, the heater due to its heating function is not allowed to be installed in an air duct.

[0012] Still more, if the deodorizing means is installed above the ice tray like the conventional example, there is a possibility of making ice including broken pieces of glass in case of the glass-tube lamp being damaged. This has posed a problem of having hazardous effects on the human body.

[0013] In addition to that, in the case of the deodorizing means obtained by coating a photocatalyst on a material forming the walls of the ice making unit, for example, the coating requires extra labor and extra time such as drying time for the process. This has posed a problem.

SUMMARY OF THE INVENTION

[0014] The embodiments of the present invention are designed for solving the problems mentioned above. It is an object of one embodiment of the present invention to minimize the weight and size of a deodorizing means using a photocatalyst. In addition to that, it is another object of one embodiment of the present invention to eliminate any impropriety of a deodorizing means placed near food in a refrigerator. Furthermore, it is another object of one embodiment of the present invention to provide a material such as a photocatalyst at a low cost.

[0015] These and other objects of the embodiments of the present invention are accomplished by the present invention as hereinafter described in further detail.

[0016] According to one aspect of the present invention, a fridge-freezer may include a deodorizing unit. The deodorizing unit may include a filter having a photocatalyst, and a light emitting unit for emitting ultraviolet rays.

[0017] The light emitting unit may have an LED (Light Emitting Diode) for emitting the ultraviolet rays.

[0018] The filter may include an absorption material.

[0019] The deodorizing unit may have a solid structure with a fixed distance kept between the filter and the light emitting unit.

[0020] The fridge-freezer may include a damper unit. The deodorizing unit and the damper unit may have a solid structure.

[0021] The deodorizing unit may include a transparent case which covers the light emitting unit and transmits the ultraviolet rays.

[0022] Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The present invention will become more fully understood from the detailed description given hereinafter and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention, and wherein:

[0024] **FIG. 1** is an overall perspective view of a refrigerator according to a first embodiment of the present invention;

[0025] **FIG. 2** is a sectional view of the refrigerator according to the first embodiment of the present invention;

[0026] **FIG. 3** is a perspective view of a filter according to the first embodiment of the present invention;

[0027] **FIG. 4** is a simplified explanatory drawing of the filter of **FIG. 3** according to the first embodiment of the present invention;

[0028] **FIG. 5**(*a*) is a detailed drawing of the filter illustrating the components thereof according to the first embodiment of the present invention;

[0029] **FIG. 5**(*b*) is a detailed drawing of the filter illustrating the sintered grains thereof according to the first embodiment of the present invention;

[0030] **FIG. 6** is a perspective view of a light emitting unit of the refrigerator according to the first embodiment of the present invention;

[0031] **FIG. 7** is a relative light distribution characteristic drawing illustrating a light emission characteristic of an LED according to the first embodiment of the present invention;

[0032] **FIG. 8** is a perspective view of a measuring unit for measuring the relative light distribution characteristic of the LED according to the first embodiment of the present invention;

[0033] **FIG. 9** is a drawing of an electric circuit of the substrate of the refrigerator according to the first embodiment of the present invention;

[0034] **FIG. 10** is a flow chart for controlling the refrigerator according to the first embodiment of the present invention;

[0035] **FIG. 11** is a front view of a deodorizing unit of a refrigerator according to a second embodiment of the present invention;

[0036] **FIG. 12** is a side view of the deodorizing unit of the refrigerator according to the second embodiment of the present invention;

[0037] **FIG. 13** is a front view of a modified example of the deodorizing unit of the refrigerator according to the second embodiment of the present invention;

[0038] **FIG. 14** is a side view of the modified example of the deodorizing unit of the refrigerator according to the second embodiment of the present invention;

[0039] **FIG. 15** is a front view of a modified example including a number of filters of the deodorizing unit of the refrigerator according to the second embodiment of the present invention;

[0040] **FIG. 16** is a side view of the modified example including a number of filters of the deodorizing unit of the refrigerator according to the second embodiment of the present invention;

[0041] **FIG. 17** is a front view of a deodorizing unit of a refrigerator according to a third embodiment of the present invention;

[0042] **FIG. 18** is a side view of the deodorizing unit of the refrigerator according to the third embodiment of the present invention;

[0043] **FIG. 19** is a perspective view of a damper unit of the deodorizing unit of the refrigerator according to the third embodiment of the present invention;

[0044] **FIG. 20** is a sectional view of the refrigerator illustrating the deodorizing unit which is installed in a cool air duct according to the third embodiment of the present invention;

[0045] **FIG. 21** is a perspective view of a drop-proof substrate unit of a deodorizing unit according to a fourth embodiment of the present invention;

[0046] **FIG. 22** is a front view of the deodorizing unit according to the fourth embodiment of the present invention;

[0047] **FIG. 23** is a side view of the deodorizing unit according to the fourth embodiment of the present invention;

[0048] **FIG. 24** is a front view of a modified example of the deodorizing unit according to the fourth embodiment of the present invention;

[0049] **FIG. 25** is a front view of a deodorizing unit according to a fifth embodiment of the present invention;

[0050] **FIG. 26** is a front view of a deodorizing unit according to a sixth embodiment of the present invention;

[0051] **FIG. 27** is a schematic drawing of air ducts in which deodorizing units are provided in a refrigerator according to a seventh embodiment of the present invention;

[0052] **FIG. 28** is a perspective view of a refrigerator according to a conventional invention illustrating a relevant part of the refrigerator;

[0053] **FIG. 29** is a sectional view of a glass-tube heater for deodorization illustrating a photocatalyst of the refrigerator according to the conventional invention;

[0054] **FIG. 30** is a front view of the refrigerator according to the conventional invention illustrating a relevant part of the refrigerator; and

[0055] **FIG. 31** is a front view of a glass-tube heater for deodorization illustrating a relevant part of a refrigerator according to a second conventional art.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0056] Reference will now be made in detail to the present preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals indicate like elements through out the several views.

[0057] Embodiment 1.

[0058] **FIG. 1** is a perspective view of a refrigerator according to a first embodiment of the present invention. **FIG. 2** is a sectional view of the refrigerator illustrating cool airflow. **FIG. 3** is a perspective view of a filter according to the first embodiment of the present invention. **FIG. 4** is a simplified explanatory diagram of a filter surface of the filter of **FIG. 3**. **FIG. 5**(*a*) is a detailed drawing of absorption components on the filter surface of **FIG. 4**. **FIG. 5**(*b*) is a detailed drawing of sintered grains on the filter surface of **FIG. 4**. **FIG. 6** is a perspective view of a light emitting unit on which light emitting diodes (hereinafter referred to as LEDs) are mounted.

[0059] With reference to the figures, a reference numeral **1** denotes a body of the refrigerator which is separated into such compartments as a refrigerator room **9**, a convertible room **10**, an ice-maker **2**, a vegetable room **11** and a freezer compartment **12**. A reference numeral **13** denotes a cool air duct formed inside the body **1** of the refrigerator. The cool air duct **13** communicates with the refrigerator room **9**, the convertible room **10**, the ice-maker **2**, the vegetable room **11** and the freezer compartment **12**. The cool air duct **13** includes a cooling chamber **16** in which a cooling unit **14** is installed in a lower part and a fan **15** is installed in an upper part. A reference numeral **17** denotes a filter which is installed in a part of the cool air duct. The filter **17** is formed with wavy inner padding 中芯 **17***a* and flat liners **17***b* being woven together in lamination layers as shown in **FIG. 4**. The inner padding **17***a* may be formed, as one example shown in **FIG. 5**(*a*), with a fibrous pulp material **17***h* being impregnated with an absorption material **17***f*, which is composed of zeolite **17***c*, manganese oxide **17***d* and copper oxide **17***e*, and a photocatalyst **7***a* such as a titanium oxide **17***g* which is activated by ultraviolet rays. As another example shown in **FIG. 5**(*b*), the inner padding **17***a* may be formed with sintered grains of the absorption material **17***f*, which is composed of Zeolite **17***c*, manganese oxide **17***d* and copper oxide **17***e*, and the photocatalyst **7***a* such as the titanium oxide **17***g* which is activated by ultraviolet rays. The inner padding **17***a* thus includes the mixture of the absorption material **18**, which is composed of zeolite **17***c*, manganese oxide **17***d* and copper oxide **17***e*, and the photocatalyst **7***a* such as the titanium oxide **17***g* which is activated by ultraviolet rays for the purpose of making use of an absorption property of odor elements such as methyl-mercaptan and tri-methyl-amine which are given off from food stored in the refrigerator. The inner padding **17***a* may be obtained by varying the proportion and composition of the absorption material **17***f* and the photocatalyst **17***a*.

[0060] Still alternatively, the filter **17** may be further mixed with a silver component which has an antibacterial action, or the filter **17** may be provided with a blow hole whose size may be designed for allowing ethylene to be removed. The size and surface area of the filter **17** may be selected adaptively depending on the condition of a user environment. A reference numeral **19** denotes a light emitting unit including a substrate, which is installed above the filter **17** placed in the part of the cool air duct. The light emitting unit **19** is provided with lead wires **19***a* for connection, which are fixed on one end of the substrate. The light emitting unit **19** is provided also with two or more chipped LEDs **19***b* for emitting ultraviolet rays and a chipped Zener diode **19***c* for preventing static electricity mounted on the surface of the substrate. Alternatively, the same effect may be obtained by the light emitting unit **19** based on a discrete mounting in which holes are made through the substrate, the lead wires are inserted through the holes and then mounted on the substrate by soldering.

[0061] It is to be noted that the same effect may be obtained with at least a single LED mounted on the body of the light emitting unit.

[0062] **FIG. 7** is a diagram of a relative light distribution characteristic illustrating a light emission characteristic of the LED. The figure shows relative intensity for relative light distribution in an irradiation range in X and Y directions. The relative intensity may be obtained when the central light intensity is 100. In **FIG. 7**, the solid line indicates the light distributions in the X direction and the broken line indicates the light distributions in the Y direction.

[0063] **FIG. 8** is a perspective view of a light measuring unit for measuring the relative light distribution characteristic of the LED. A reference numeral **20** denotes a measuring base on which the LED **19***b* is mounted.

[0064] **FIG. 9** shows an electric circuit diagram of the light emitting unit. The electric circuit has two LEDs **19***b* being connected in series and the Zener diode **19***c* for preventing static electricity being connected in parallel to the LEDs **19***b*. The LEDs **19***b* emit light when DC5V-DC12V is applied and an electric current of about 10 mA-20 mA is supplied at the both ends of the lead wires **19***a*. This LED **19***b* acts with such weak power as DC5V to DC12V and generates ultraviolet rays with a wave length of about 380 nm. With such a small value of about 10 mA-20 mA, the light emitting unit will be safe even if a number of LEDs **19***b* is required to be mounted thereon depending on the intensity of light and the irradiation range needed.

[0065] It is to be noted that the LEDs are connected in series in this example, but the same effect may alternatively be obtained if the LEDs is connected in parallel to each other.

[0066] The thus formed filter **17** may be placed at a location where the filter is exposed to air within the refrigerator, for example, in the part of the air duct within the refrigerator as shown in **FIG. 2**. This allows the filter **17** to absorb odor elements, thereby removing odors from cool air in the refrigerator. Furthermore, the LED **19***b* may be placed at a location near the filter **17** where light may be irradiated. As a result, the titanium oxide included in the filter **17** is divided into electrons (−) and electron holes (+) by means of ultraviolet rays, thereby producing a radical. The radical has an oxidation decomposition effect on floating odor elements

and a deoxidization reaction to decompose odor elements absorbed by the filter **17**. Therefore, the life of the filter **17** may be prolonged.

[**0067**] It is to be noted that although power may be supplied continuously to the LED **19***b*, an intermittent supply of power by such as synchronizing with the fan motor **15***a* may also be effective. In this case, a required life for the LED **19***b* may be shortened and the unit price of the LED **19***b* may be lowered. Still alternatively, a deodorizing switch operable by the user may be provided in the refrigerator. This allows power to be supplied arbitrarily to the LED.

[**0068**] **FIG. 10** is a simplified control flow chart. In a step **101**, it is judged whether a switch SW is turned on or not by the user while the refrigerator is working. In a step **102**, it is judged whether the fan motor is under conditions for driving or not. Therefore, in this case, power is supplied to the LED only when the switch is turned on and also the fan motor is under conditions for driving.

[**0069**] Embodiment 2.

[**0070**] **FIG. 11** is a front view of a deodorizing unit of a refrigerator according to a second embodiment of the present invention. **FIG. 12** is a side view of the deodorizing unit of the refrigerator according to the second embodiment. With referring to the figures, a reference numeral **21** denotes a deodorizing unit including a pair of angular top frames **21***a*. In a lower part of the frames, the filter **17** is fitted and in an upper part thereof, the light emitting unit **19** is fitted with the both ends being fixed so that the LEDs **19***b* face the surface of the filter **17**.

[**0071**] Thus, by compactly forming the light emitting unit **19** by using the LEDs **19***b*, the light emitting unit **19** is allowed to be installed more flexibly in the air duct in the refrigerator. The filter **17** and the LEDs **19***b* of the light emitting unit **19** are allowed to keep a fixed distance therebetween, so that a stable precision may be achieved. Furthermore, a material handling performance may be improved. The product is removable on a unit basis for decomposition thereby effectively recyclable.

[**0072**] It is to be noted that the shape of the deodorizing unit **21** is not fixed. **FIG. 11** shows an example of the deodorizing unit **21** having an angular top for the purpose of reducing air resistance in the air duct. Alternatively, as shown in **FIG. 13** and **FIG. 14**, the deodorizing unit **21** may be changed to have a slope on one side depending up the use.

[**0073**] Still alternatively, as shown in **FIG. 15** and **FIG. 16**, the LEDs **19***b* may be mounted on the both sides of the substrate of the light emitting unit **19** and the filters **17** may be fitted below as well as above the light emitting unit **19**. Thus, two filters are allowed to be refreshed by means of the single substrate. Furthermore, the filter may alternatively be placed at the center and the LED substrate may be provided on each side of the filter. As a result, the filter **17** is allowed to have the irradiation of ultraviolet rays equally on the both sides. This has an effect of enhancing a refreshing efficiency for the filter **17**.

[**0074**] Embodiment 3.

[**0075**] **FIG. 17** is a front view of a deodorizing unit of a refrigerator according to a third embodiment of the present invention. **FIG. 18** is a side view of the deodorizing unit of the refrigerator according to the third embodiment. **FIG. 19** is a perspective view of a damper unit. **FIG. 20** is a sectional view of the refrigerator in which the deodorizing unit is installed in the cool air duct. With referring to the figures, reference numeral **21** represents the body of a deodorizing unit which is installed in the cool air duct **13** of the refrigerator **1** with a cool air channel **21***b* being opened. The deodorizing unit **21** is provided with a pair of adjustment catches **21***c* for fixing the filter **17** so as to clog the cool air channel **21***b* in an upper part on the both sides of the body. On an end panel of the body, the deodorizing unit **21** is provided with a wall **21***d* which is in contact with the whole surface of the end panel and extends upwards. A reference numeral **22** denotes a transparent case which is placed in an upper part of the wall and contains the light emitting unit **19** including the LEDs **19***b*. The transparent case **22** is fitted so that the LEDs **19***b* of the light emitting unit **19** face downwards. A reference numeral **23** denotes a damper unit which is normally installed in the cool air duct **13** in the refrigerator **1**. The damper unit **23** is composed of a driving part **23***a* including a built-in motor, a frame part **23***c* which is provided horizontally next to the driving part **23***a* with an opening **23***b*, and a baffle part **23***d* for opening/closing the opening. The thus composed damper unit **23** is mounted on the bottom surface of the body of the deodorizing unit **21** so as to clog the opening **23***b* of the body. A reference numeral **23***e* denotes a spring which is used for keeping the baffle part **23***d* to be in a closed state.

[**0076**] It is to be noted that this damper unit is installed in the air duct **13** as illustrated in **FIG. 12** if used for controlling the temperature of the refrigerator room. In this case, the damper unit opens/closes the baffle to control the flow rate of cool air so as to keep a constant temperature in the refrigerator room.

[**0077**] Embodiment 4.

[**0078**] **FIG. 21** is a perspective view of a drip-proof substrate unit of a deodorizing unit of a refrigerator according to a fourth embodiment. **FIG. 22** is a front view of the deodorizing unit which the drip-proof substrate unit is mounted on. **FIG. 23** is a side view of the deodorizing unit which the substrate unit is mounted on. With referring to the figures, reference **19** represents the light emitting unit, reference **19***a* represents the lead wires, reference numeral **19***b* represents LEDs, and reference numeral **19***c* represents the Zener diode for preventing static electricity. A reference numeral **24** denotes a drip-proof substrate case which is composed of an acrylic material or a glass material containing the built-in light emitting unit **19**. An opening of the case is sealed and clogged by a seal section **25** with the light emitting unit **19** being built inside the drip-proof substrate case.

[**0079**] The thus formed drip-proof substrate unit allows no dew to be formed on the LED substrate assembly if located at a low temperature, even when warm air flows in through the refrigerator as a result of opening a door of the refrigerator for a long time, for example. Therefore, such as a rust relating disconnection in the lead wires or corrosion in soldered parts may be prevented. It is to be noted that the drip-proof case **24** is made of a material transmitting ultraviolet rays such as acrylic or glass. Alternatively, the case may be vacuumed inside also to prevent dew forming inside the case.

[0080] Further alternatively, as shown in **FIG. 24**, the filter **17** is fitted in a lower part of a pair of frames **21***a*. Above the filter **17**, the drip-proof case is fixed on the both sides with the side of the lead wires **19***a* being slanted downwards so that the LEDs **19***b* of the light emitting unit **19** face the surface of the filter **17**. Thus, by placing the drip-proof case in a slanted manner, in case of a drip of water **26** entering the case, the water will be kept on one side as illustrated in the figure, so that the substrate is allowed to be less possible to be watered.

[0081] Embodiment 5.

[0082] **FIG. 25** is a diagram illustrating the drip-proof substrate unit **24** of the fourth embodiment with an additional lens section **27** for concentrating ultraviolet rays. The thus formed drip-proof substrate unit may achieve an effective irradiation of ultraviolet rays to the filter. It is to be noted that light concentration may be adjusted depending on the size of the filter.

[0083] Embodiment 6.

[0084] **FIG. 26** is a perspective view of the substrate of a deodorizing unit according to a sixth embodiment. With referring to the figure, reference **19** represents the light emitting unit composed of a substrate, reference **19***a* represents the lead wires, reference numeral **19***b* represents LEDs, and reference numeral **19***c* represents the Zener diode for preventing static electricity. A reference numeral **28** denotes second reflection materials such as stainless steel. The second reflection materials **28** have circular openings **28***a* at the center. From the edges of the openings, slanting conic surfaces **28***b* are formed so as to have reflecting surfaces.

[0085] The deodorizing unit thus formed concentrates ultraviolet rays which are emitted by the LEDs **19***b* of the light emitting unit **19** and then reflected by the second reflection materials **28**. As a result, an efficient irradiation of ultraviolet rays may be achieved to the filter. It is to be noted also in this case that light concentration may be adjusted depending on the size of the filter.

[0086] Embodiment 7.

[0087] **FIG. 27** is a schematic drawing of air ducts in which deodorizing units are provided in a refrigerator according to a seventh embodiment. With referring to the figure, reference numeral **15** represents the fan, a reference sign **13***a* denotes a first air duct, a reference sign **13***b* denotes a second air duct, a reference sign **13***c* denotes a third air duct, a reference sign **13***d* denotes a fourth air duct and reference **23** represents the damper units. The air ducts **13***a*-**13***d* guide cool air to compartments at different temperatures, respectively, in the refrigerator. The first air duct **13***a* is provided with the deodorizing unit **21** and leads to a first compartment (e.g., the refrigerator room). The second air duct **13***b* is provided with the deodorizing unit **21** and leads to a second compartment (e.g., the ice-maker). The third air duct **13***c* is provided with the deodorizing unit **21** and leads to a third compartment (e.g., the convertible room). The fourth air duct is provided with the deodorizing unit **21** and leads to a fourth compartment (e.g., the freezer compartment).

[0088] By installing the deodorizing units **21** equipped with the damper units **23** at the places of the first air duct **13***a*, the second air duct **13***b*, the third air duct **13***c* and the fourth air duct **13***d*, respectively, cool air flowing into the respective compartments may be deodorized. It is to be noted that the number of the air ducts may correspond to the number of compartments in the refrigerator. Hence, deodorized cool air may be supplied sufficiently to a compartment which requires deodorization.

[0089] The effects of the embodiments of the present invention may be summarized as follows.

[0090] The fridge-freezer according to one embodiment of the present invention is provided with the deodorizing unit including the filter, which has a photocatalyst or a mixture of a photocatalyst and an absorption material, and the light emitting unit which has the LED for emitting ultraviolet rays. As a result, light maybe emitted by using a low electric current. As an effect, odors given off from food and others may be removed efficiently so that the users are allowed to have a pleasant and comfortable use of the refrigerator.

[0091] Furthermore, the fridge-freezer according to one embodiment of the present invention is provided with the deodorizing unit including the filter and the light emitting unit which are solidly formed with a fixed distance being kept therebetween. As a result, a material handling performance of the fridge-freezer is improved. As an effect, the fridge-freezer is efficiently removable for decomposition thereby highly recyclable.

[0092] Furthermore, the fridge-freezer according to one embodiment of the present invention is provided with the deodorizing unit and the damper unit which are solidly formed. As an effect, the number of parts required for the refrigerator may be reduced.

[0093] Furthermore, the fridge-freezer according to one embodiment of the present invention is provided with the light emitting unit which is covered with the transparent case which transmits ultraviolet rays. As a result, even if glass is used as a material for the drip-proof structured case, the case does not easily receive such stress as to damage the case in material handling because the light emitting part is small. As an effect, an external stress is not easily exerted on the glass case if the case is placed in the air duct.

[0094] Furthermore, the fridge-freezer according to one embodiment of the present invention is provided with the transparent case which has the drip-proof structure. As a result, even if glass is used as a material for the drip-proof structured case, the case does not easily receive such stress as to damage the case in material handling because the light emitting part is small. As an effect, an external stress is not easily exerted on the glass case if the case is placed in the air duct. In addition to that, the case may protect the inside from dew forming or being watered without affecting the performance.

[0095] Furthermore, the fridge-freezer according to one embodiment of the present invention is provided with the transparent case that is formed by the material which may transmit ultraviolet rays and the lens section. As an effect, ultraviolet rays may be concentrated efficiently and irradiation efficiency to the filter may be enhanced.

[0096] Furthermore, the fridge-freezer according to one embodiment of the present invention is provided with the

light emitting unit which has the reflection materials surrounding the LED. As an effect, ultraviolet rays may be concentrated efficiently and irradiation efficiency to the filter may be enhanced.

[0097] Furthermore, the fridge-freezer according to one embodiment of the present invention is provided with the light emitting unit being installed in the cool air duct through which cool air is guided to two or more compartments in different temperatures and which has one or more flow rate controllers being installed therein. This may facilitate the deodorization, as an effect, of the individual compartments in different temperatures.

[0098] The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

What is claimed is:

1. A fridge-freezer comprising a deodorizing unit;

wherein the deodorizing unit includes,

a filter having a photocatalyst, and

a light emitting unit for emitting ultraviolet rays.

2. The fridge-freezer of claim 1, wherein the light emitting unit has an LED (Light Emitting Diode) for emitting the ultraviolet rays.

3. The fridge-freezer of claim 1, wherein the filter further includes an absorption material.

4. The fridge-freezer of claim 1, wherein the deodorizing unit has a solid structure with a fixed distance kept between the filter and the light emitting unit.

5. The fridge-freezer of claim 1, further comprising a damper unit;

wherein the deodorizing unit and the damper unit have a solid structure.

6. The fridge-freezer of claim 1, wherein the deodorizing unit includes a transparent case which covers the light emitting unit and transmits the ultraviolet rays.

7. The fridge-freezer of claim 6, wherein the transparent case is drip-proof.

8. The fridge-freezer of claim 6, wherein the transparent case has a lens in part.

9. The fridge-freezer of claim 2, wherein the light emitting unit includes a reflecting material which is placed around the LED.

10. The fridge-freezer of claim 1, comprising a plurality of flow-rate regulators for regulating a flow rate of air in a cool air duct in order to control temperatures;

wherein a plurality of deodorizing units corresponding to the plurality of flow-rate regulators is placed in the cool air ducts.

11. The fridge-freezer of claim 10, wherein the plurality of flow-rate regulators are damper units.

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