

TITLE OF THE INVENTION

Controller For Low-Temperature Display Case

BACKGROUND OF THE INVENTION

The present invention relates to a controller for a low-temperature display case that is installed in stores, such as supermarkets and convenience stores.

As described in Japanese Examined Patent Publication No. Hei 7-1135 (F25B47/02), or Japanese Examined Patent Publication No. Hei 7-6713 (F25B47/02), conventionally, a plurality of low-temperature display cases (open front display cases) are installed in stores, such as supermarkets, and refrigerant is supplied to evaporators in the low-temperature display cases by condensing units that are separately located in a machine room outside the store.

Fans drive air cooled to predetermined temperatures by the evaporators into storage chambers to refrigerate products that are displayed therein, and lamps provide illumination in the storage chambers to enhance the appearance of the displayed products.

Recently, to provide increased power consumption efficiency, means have been sought by which to level off the demand for power. For low-temperature display cases that are in constant operation during the hours a store is opened, the leveling off of power consumption is a problem.

SUMMARY OF THE INVENTION

To overcome the conventional technical problem, it is one object of the present invention to provide a controller, for a low-temperature display case, that can contribute to the leveling off of the demand for power.

That is, a controller according to the present invention that is applied



for a low-temperature display case, for which refrigeration of a storage chamber is controlled by discharging cooled air, raises a set cooling temperature for the storage chamber for a predetermined period during those hours a store is open.

A controller according to the present invention that is applied for a low-temperature display case, for which refrigeration is controlled by discharging cooled air into a storage chamber wherein illumination is provided by lamps, raises a set temperature for the refrigeration and reduces the illumination provided by the lamps for a predetermined period during those hours a store is open.

According to the controller of the present invention for a low-temperature display case, the predetermined period is set to a period wherein the demand for power peaks.

A controller according to the present invention that is applied for a low-temperature display case, for which refrigeration is controlled by discharging cooled air into a storage chamber, raises a set temperature for the refrigeration when there is an external temperature rise during those hours a store is open.

A controller according to the present invention that is applied for a low-temperature display case, for which refrigeration is controlled by discharging cooled air into a storage chamber wherein illumination is provided by lamps, raises a set temperature for the refrigeration and reduces the illumination provided by the lamps when there is an external temperature rise during those hours a store is open.

A controller according to the present invention that is applied for a low-temperature display case, for which refrigeration is controlled by discharging cooled air into a storage chamber, raises a set temperature for

the refrigeration when condensation pressure in a condensing unit rises during those hours a store is open.

A controller according to the present invention that is applied for a low-temperature display case for which cooling is controlled by discharging cooled air into a storage chamber wherein illumination is provided by lamps, raises a set temperature for the refrigeration and reduces the illumination provided by the lamps when condensation pressure in a condensing unit rises during those hours a store is open.

A controller according to the present invention that is applied for a low-temperature display case, for which refrigeration is performed by discharging cooled air into a storage chamber, raises a set temperature for the refrigeration when a demand for power is raised during those hours a store is open.

A controller according to the present invention that is applied for a low-temperature display case, for which refrigeration is controlled by discharging cooled air into a storage chamber wherein illumination is provided by lamps, raises a set temperature for the refrigeration and reduces the illumination provided by the lamps when a demand for power is raised during those hours a store is open.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a vertical cross-sectional view of a low-temperature display case according to one embodiment of the present invention;

Fig. 2 is a diagram for explaining a piping arrangement in a storage chamber of a low-temperature display case according to the embodiment;

Fig. 3 is a block diagram illustrating an electric circuit of a controller for a low-temperature display case according to the present invention; and

Fig. 4 is a timing chart for explaining input, temperature and

illumination changes and condensing unit changes for the low-temperature display case of the embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred embodiment of the present invention will now be described in detail while referring to drawings.

A low-temperature display case 1 in this embodiment is a vertical, open-front open display case, and comprises an insulating wall 32 having a U shape in cross section, and side walls (not shown) attached to either side of the insulating wall 32 at an installation site. An outer layer partition plate 34 and an inner layer partition plate 36, separated by an intervening space, are attached inside the insulating wall 32 so as to define an outer layer duct 37 between the insulating wall 32 and the outer layer partition plate 34, an inner layer duct 38 between the inner and outer layer partition plates 36 and 34, and a storage chamber 39 inside the inner wall partition plate 36.

A plurality of shelves 41 are provided in the storage chamber 39, and fluorescent lamps 40 for illumination are provided at the lower front portions of the shelves, on the ceiling of the storage chamber 39, and beneath a canopy 37. A deck pan 42 is attached at the bottom of the storage chamber 39, and a bottom duct 43 is formed below the deck pan 42 that communicates with the ducts 37 and 38. A fan case 44 incorporating a fan 45 is located in the bottom duct 43. An evaporator 46 is vertically arranged in the lower portion of the inner duct 38 that is located at the rear of the storage chamber 39.

When the fan 45 in the fan case 44 is activated, air in the bottom duct 43 is driven toward the rear inner and outer ducts 37 and 38. Part of the air is driven upward through the outer duct 37, while the remainder passes

through the evaporator 46, wherein heat exchange takes place, passes into the inner duct 38 and is driven upward. The air is thereafter discharged through the inner and outer outlets 52 and 53 toward an inlet 54 at the lower edge of the display case.

With this process, an internal cooled air curtain and an external protective air curtain, which prevents or inhibits the entry of external air, are formed across an open portion 51 in the storage chamber 39. One part of the air, that in the internal cooled air curtain, circulates through and cools the storage chamber 39. The cooled air is returned through the inlet 54 to the bottom duct 43, and is impelled toward the fan 45.

In Fig. 2, three low-temperature display cases (vegetable and fruit refrigerating cases) 1a are arranged in parallel for the storage and display of vegetables and fruit (products). An additional five low-temperature display cases (chilled fish cases) 1b are arranged in parallel for the storage and display of fish (products).

The low-temperature display cases 1a and 1b are installed along the walls of a store, such as a supermarket, as is shown in Fig. 2. A condensing unit for refrigeration 11 and a condensing unit for chilling 12 are separately located in a machine room 13 outside the store.

The condensing units 11 and 12 are constituted by a compressor and a condenser. The inlets of the evaporators 46 in the low-temperature display cases (refrigeration cases) 1a are connected in parallel, via solenoid valves 14 and expansion valves 16, respectively, to a liquid refrigerant pipe 17 for the condensing unit 11. The outlets of the evaporators 46 are connected in parallel to a gas refrigerant pipe 18 for the condensing unit 11.

The inlets of the evaporators 46 in the low-temperature display cases (chilled cases) 1b are connected in parallel, via solenoid valves 19 and

expansion valves 21, respectively, to a liquid refrigerant pipe 22 for the condensing unit 12. The outlets of the evaporators 46 are connected in parallel to a gas refrigerant pipe 23 for the condensing unit 12.

Fig. 3 is a block diagram illustrating the electric circuit of a controller 56 for the low-temperature display cases 1 (1a, 1b). The controller 56 is constituted by a general-purpose microcomputer 57. The input terminal of the microcomputer 57 is connected to a shift amount set switch 58 for night set back (NSB) and a shift amount set switch 59 for demand set back (DSB), which will be described later.

An illumination switch 61 is connected to the NSB input of the microcomputer 57. The output terminal of a condensation pressure sensor 62 for detecting condensation pressure at the evaporators 46 is connected to the DSB input terminal. The output of a temperature sensor 63 for detecting the temperature (discharged air temperature TDA) of air that is discharged from the inner layer duct 38 is transmitted to the microcomputer 57. The temperature sensor 63 is provided in the inner layer duct 38 that is located upstream of the inner outlet 53, as is shown in Fig. 1.

The solenoid valve 14 or 19 is connected to the output terminal of a temperature control contact point 64 of the microcomputer 57. An electronic stabilizer 67 is connected to the output terminal of a light adjustment contact point 66. The fluorescent lamps 40 are connected to the electronic stabilizer 67.

With this structure, the operation will now be described while referring to the timing chart in Fig. 4. An explanation will be given for the low-temperature display case 1b and the chilled condensing unit 12. The operation for the low-temperature display case 1a and the refrigeration condensing unit 11 will not be described because the operations of the

solenoid valves 14 and the expansion valves 16 are the same and only the set temperatures differ.

During the hours the store is open, from 10 AM to 9 PM, for example, when a light switch 61 has been closed by a user, the microcomputer 57 permits the electronic stabilizer 67 to turn the fluorescent lamps 40 on. The microcomputer 57 also has a 24 hour timer which is operated by a program.

A three-phase alternating current is supplied to the compressor of the chilled condensing unit 12. When the compressor is operating, the refrigerant is compressed and passes through the liquid refrigerant pipe 22.

At the expansion valves 21, the pressure on the refrigerant is reduced, and the refrigerant is supplied to the evaporators 46 in the low-temperature display cases 1b. At the evaporators 46, the refrigerant is evaporated and heat is extracted from air passing through the evaporators 46, thereafter the air (cooled air) passes through the inner layer duct 38 and is discharged from the inner outlet 53, as previously described.

Assuming that the temperature of the air discharged from the inner layer outlet 53 (discharged air temperature TDA) is set to -5°C . During the hours the store is open and while the light switch 61 is closed (in the ON state), and during the periods extending from 10 AM to 1 PM and from 3 PM to 9 PM, while the set value of the discharged air temperature TDA is -5°C , the microcomputer 57 employs the temperature switch 64 to open and close the solenoid valves 19.

More specifically, when the discharged air temperature TDA, which is detected by the temperature sensor 63, rises to -3°C , the microcomputer 57 opens the solenoid valves 19. When the TDA is reduced to -5°C , the microcomputer 57 closes the solenoid valves 19. When all of the solenoid

valves 19 are closed, the compressor of the chilled condensing unit 12 is halted. By means of this cooling control, for the products that are displayed on the shelves 41 in the storage chambers 39 are maintained at a temperature TG of 0°C.

The input (power) PR of the chilled condensing unit 12 (compressor) during this period is about 52 kW for the low-temperature display cases 1b in this embodiment. In this period, the microcomputer 57 opens the light adjustment switch 66 so that the fluorescent lamps 40 are turned on, while the electron stabilizer 67 sets the luminance L of the fluorescent lamps 40 to 2000 lx (total value). The input (power) PC (the total) for the fluorescent lamps 40 in this case (period) is about 24 kW.

For the period during which the store is closed, from 9 PM to 10 AM the next day, when the light switch 61 has been opened (turned OFF) by a user, the microcomputer 57 permits the electron stabilizer 67 to turn off the fluorescent lamps 40. At this time, the value for the discharged air temperature TDA is set to -3°C, which is a two degree shifted up from (a higher temperature than) -5°C, and the temperature adjustment switch 64 is used to open and close the solenoid valve 19 (night set back). This shift width can be arbitrarily set with an NSB shift amount set switch 58.

More specifically, when the discharged air temperature TDA detected by the temperature sensor 63 is raised to -1°C, for example, the microcomputer 57 opens the solenoid valve 19. When the temperature TDA is reduced to -3°C, the microcomputer 57 closes the solenoid valve 19. However, since the fluorescent lamps 40 are turned off during the closing hours, as previously described, and the amount of heat generated is zero, and the opening 51 of the low-temperature display case 1b is closed by a night cover (not shown), the products in the storage chamber 39 are

maintained at a temperature TG of 0°C.

During the hours the store is open from 1 PM to 3 PM, the discharged air temperature TDA is set to -3°C, which is a 2°C degrees shift upward (raise) from -5°C, and the microcomputer 57 uses the temperature adjustment switch 64 to open and close the solenoid valve 19 (demand set back). The shift width can be arbitrarily set by a DSB shift amount switch 59.

More specifically, when the discharged air temperature TDA detected by the temperature sensor 63 is raised to -1°C, for example, the microcomputer 57 opens the solenoid valve 19. When the temperature TDA is reduced to -3°C, the microcomputer 57 closes the solenoid valve 19.

In addition, in this period the microcomputer 57 closes the light adjustment switch 66 so that the fluorescent lamps 40 are turned on while the electron stabilizer 67 reduces the input (power) PC (total value) for the fluorescent lamps from 40 to 21 kW. The luminance L of the fluorescent lamps 40 is reduced to about 1800 lx (total value).

The period from 1 PM to 3 PM is the period during a day when the power demand peaks. In this embodiment, as is described above, since the set value for the discharged air temperature TDA is raised by 2°C, in this case (period) the input (power) PR of the chilled condensing unit 12 (compressor) is reduced to approximately 44 kW. As the input (power) PC (total value) for the fluorescent lamps 40 is also reduced to about 21 kW, the power consumption according to this embodiment can be reduced by a total of 11 kW when the power demand peaks, effectively contributing to the leveling off of the power demand.

Although the temperature TG is to be raised in response to the rise of

the discharged air temperature TDA, the luminance L of the fluorescent lamps 40 is reduced, and the amount of heat generated is reduced by 3 kW, which is the previously mentioned difference, so that the rise in the temperature TG during this period is limited to only about 5°C.

Although the luminance L of the fluorescent lamps 40 is reduced by 10%, as was previously described, this does not matter very much because such a reduction can scarcely be discerned by human beings. In consonance with the rise in the temperature of the air that is discharged into the storage chamber 39 during this period, and based on the degree to which the fluorescent lamps 40 depend on the temperature, the luminance L (brightness) becomes greater than when the input is reduced at the same temperature (-5°C) as the temperature in another period. More specifically, the value of the greater luminance mentioned previously was 1800 lx. Due to the multiplication effects, the change in the brightness in the storage chamber 39 is more difficult to recognize.

Therefore, in a case where the reduction in luminance is considered important, so long as the reduction in the input PC of the fluorescent lamps 40 is around 22 kW, the reduction of the luminance L can be reduced to about 8%. In this case, the width of a rise in the temperature TG is slightly raised.

In the above embodiment, the 24-hour timer of the micro computer 57 is employed to raise a set temperature of the discharged air temperature TDA and to reduce the luminance L of the fluorescent lamps 40 (demand set back) during the peak power demand period. However, besides the timer, an external temperature sensor may be added or the output of a conventional condensation pressure sensor 62 may be employed. Since the power demand increases when there is a rise in the external temperature, or

when the condenser pressure rises (accordingly), the above demand set back may be performed.

In a case where data concerning power demand are provided by an electric power company, if the above demand set back operation is performed when the power demand increases, the present application is effective.

As is described above, according to the present invention, in a low-temperature display case, for which cooling is controlled by discharging cooled air into a storage chamber, a set temperature for the cooling is raised for a predetermined period during the hours a store is open. Therefore, when the predetermined period is set to a period where the power demand peaks, power consumption during that period is reduced, thereby effectively contributing to the leveling off of the demand for power.

According to the present invention, in a low-temperature display case, for which cooling is controlled by discharging cooled air into a storage chamber wherein lamps are provided for illumination, a set temperature for the cooling is raised and the illumination provided by the lamps is reduced for a predetermined period during the hours a store is open. When the predetermined period is set to a period where the power demand peaks, power consumption during that period is reduced, thereby effectively contributing to the leveling off of the demand for power.

Especially, when a reduction in the illumination provided by lamps can prevent a rise in the temperature of products, which is caused by an rise of a set temperature, products can be preserved without any problem. Further, since the illumination provided by the lamps is enhanced when the set temperature is raised, power consumption can be reduced even more, or a reduction of the brightness in the storage chamber can be avoided.

According to the present invention, in a low-temperature display case, for which cooling is controlled by discharging cooled air into a storage chamber, a set temperature for the cooling is raised when the external temperature rises during the hours a store is open. By this means, power consumption is reduced for a period where the power demand peaks as a result of a rise in the external temperature, thereby effectively contributing to the leveling off of the demand for power.

According to the present invention, in a low-temperature display case for which cooling is controlled by discharging cooled air into a storage chamber wherein lamps are provided for illumination, a set temperature for the cooling is raised and the illumination provided by the lamps is reduced when the external temperature rises during the hours a store is open. By this means, power consumption is reduced for a period where the power demand peaks as a result of a rise in the external temperature, thereby effectively contributing to the leveling off of the demand for power.

Especially, when a reduction in the illumination provided by lamps can prevent a rise in the temperature of products, which is caused by an rise of a set temperature, products can be preserved without any problem. Further, since the illumination provided by the lamps is enhanced when the set temperature is raised, power consumption can be reduced even more, or a reduction of the brightness in the storage chamber can be avoided.

According to the present invention, in a low-temperature display case for which cooling is controlled by discharging cooled air into a storage chamber, a set temperature for the cooling is raised when the condensation pressure in a condensing unit rises during the hours a store is open. By this means, power consumption is reduced for a period where the condensation pressure is elevated by a rise in the external temperature and

power demand peaks, thereby effectively contributing to the leveling off of the demand for power.

According to the present invention, in a low-temperature display case for which cooling is controlled by discharging cooled air into a storage chamber wherein lamps are provided for illumination, a set temperature for the cooling is raised and the illumination provided by the lamps is reduced when the condensation pressure in a condensing unit rises during the hours a store is open. By this means, power consumption is reduced for a period where the condensation pressure is elevated by a rise in the external temperature and power demand peaks, thereby effectively contributing to the leveling off of the demand for power.

Especially, when a reduction in the illumination provided by lamps can prevent a rise in the temperature of products, which is caused by an rise of a set temperature, products can be preserved without any problem. Further, since the illumination provided by the lamps is enhanced when the set temperature is raised, power consumption can be reduced even more, or a reduction of the brightness in the storage chamber can be avoided.

According to the present invention, in a low-temperature display case for which cooling is performed by discharging cooled air into a storage chamber, a set temperature for the cooling is raised when the power demand is elevated during the hours a store is open. By this means, power consumption is reduced for a period where power demand peaks, thereby effectively contributing to the leveling off of the demand for power.

According to the present invention, in a low-temperature display case for which cooling is controlled by discharging cooled air into a storage chamber where lamps are provided for illumination, a set temperature for the cooling is raised and the illumination provided by the lamps is reduced

when the power demand is elevated during the hours a store is open. By this means, power consumption in a period where power demand peaks, thereby effectively contributing to the leveling off of the demand for power.

Especially, when a reduction in the illumination provided by lamps can prevent a rise in the temperature of products, which is caused by an rise of a set temperature, products can be preserved without any problem. Further, since the illumination provided by the lamps is enhanced when the set temperature is raised, power consumption can be reduced even more, or a reduction of the brightness in the storage chamber can be avoided.

What is claimed is:

1. A controller, for a low-temperature display case for which refrigeration of a storage chamber is controlled by discharging cooled air, which raises a set cooling temperature for said storage chamber for a predetermined period during those hours a store is open.
2. A controller, for a low-temperature display case for which refrigeration is controlled by discharging cooled air into a storage chamber wherein illumination is provided by lamps, which raises a set temperature for said refrigeration and reduces the illumination provided by the lamps for a predetermined period during those hours a store is open.
3. A controller for a low-temperature display case according to claim 1 or 2, wherein said predetermined period is set to a period wherein the demand for power peaks.
4. A controller, for a low-temperature display case for which refrigeration is controlled by discharging cooled air into a storage chamber, which raises a set temperature for said refrigeration when there is an external temperature rise during those hours a store is open.
5. A controller, for a low-temperature display case for which refrigeration is controlled by discharging cooled air into a storage chamber wherein illumination is provided by lamps, which raises a set temperature for said refrigeration and reduces said illumination provided by said lamps when there is an external temperature rise during those hours a store is open.
6. A controller, for a low-temperature display case for which refrigeration is controlled by discharging cooled air into a storage chamber, which raises a set temperature for said refrigeration when condensation pressure in a condensing unit rises during those hours a store is open.



7. A controller, for a low-temperature display case for which cooling is controlled by discharging cooled air into a storage chamber wherein illumination is provided by lamps, which raises a set temperature for said refrigeration and reduces said illumination provided by said lamps when condensation pressure in a condensing unit rises during those hours a store is open.

8. A controller, for a low-temperature display case for which refrigeration is performed by discharging cooled air into a storage chamber, which raises a set temperature for said refrigeration when a demand for power is raised during those hours a store is open.

9. A controller, for a low-temperature display case for which refrigeration is controlled by discharging cooled air into a storage chamber wherein illumination is provided by lamps, which raises a set temperature for said refrigeration and reduces said illumination provided by said lamps when a demand for power is raised during those hours a store is open.



CONTROLLER FOR LOW-TEMPERATURE DISPLAY CASE

ABSTRACT

It is one object of the present invention to provide a controller (56) for a low-temperature display case (1), that can contribute to the levelling off of the demand for power. A controller according to the present invention raises a set cooling temperature for a storage chamber (39) for a predetermined period during those hours a store is open.

Fig. 3.

FIG. 1

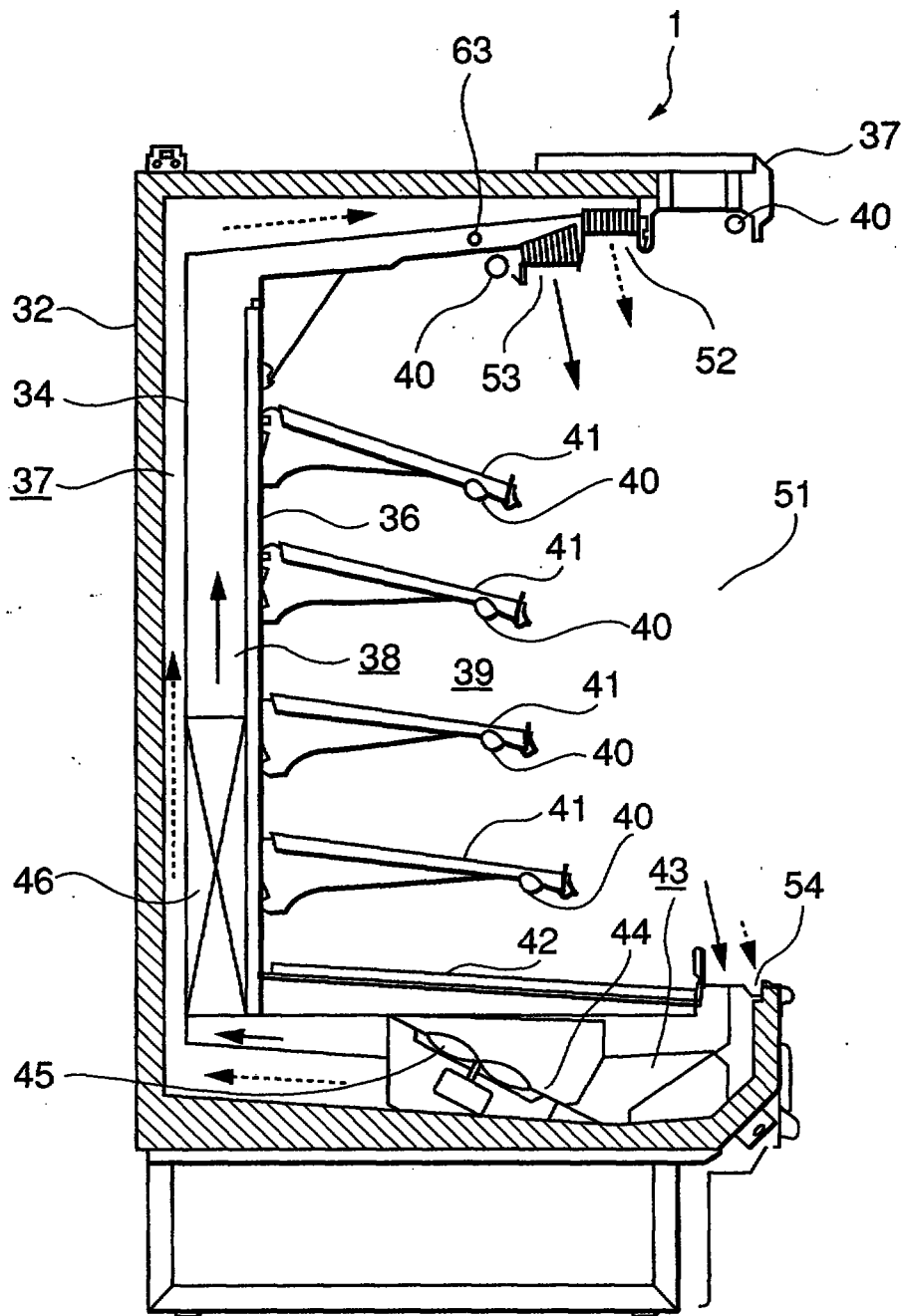


FIG.2

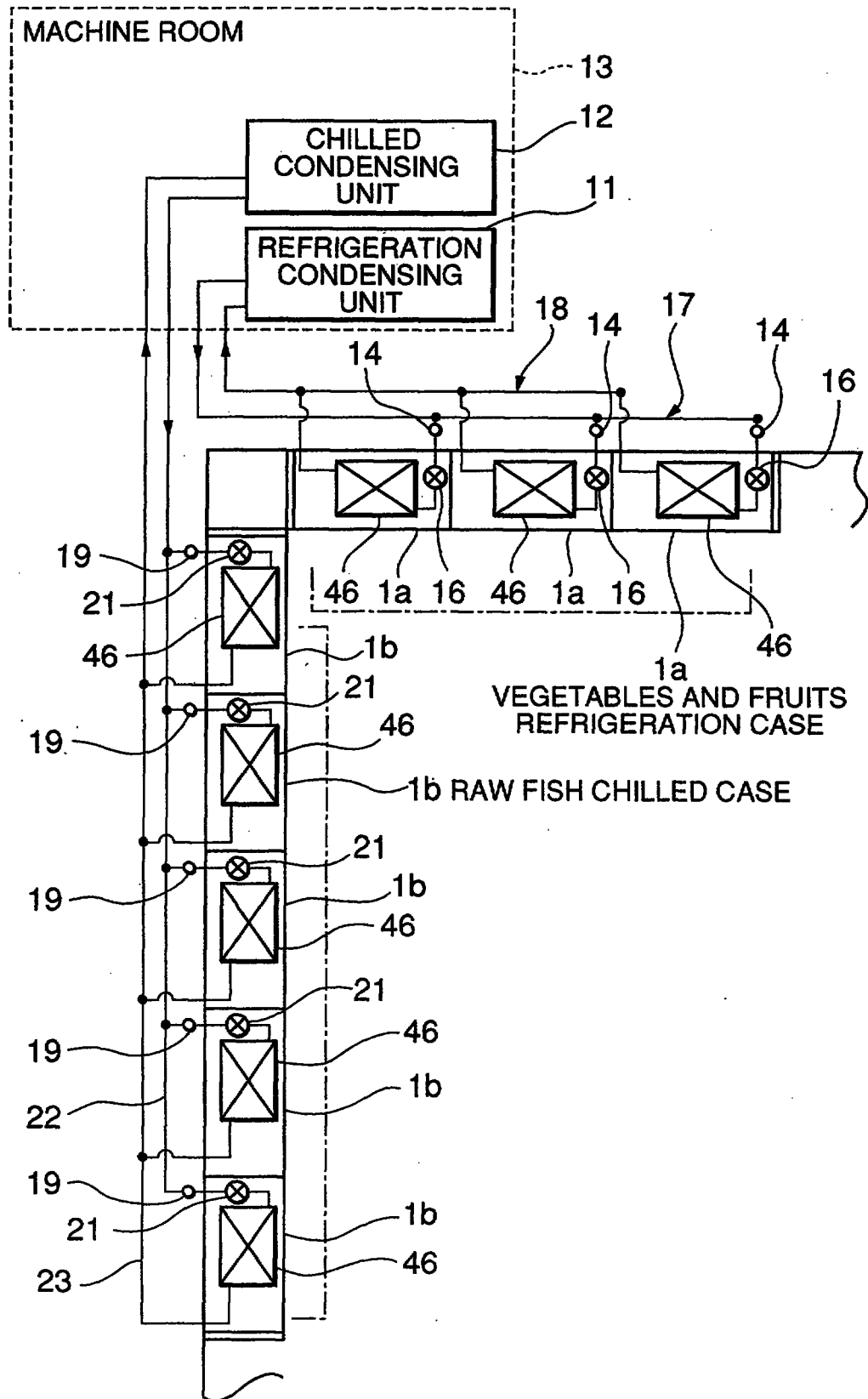


FIG.3

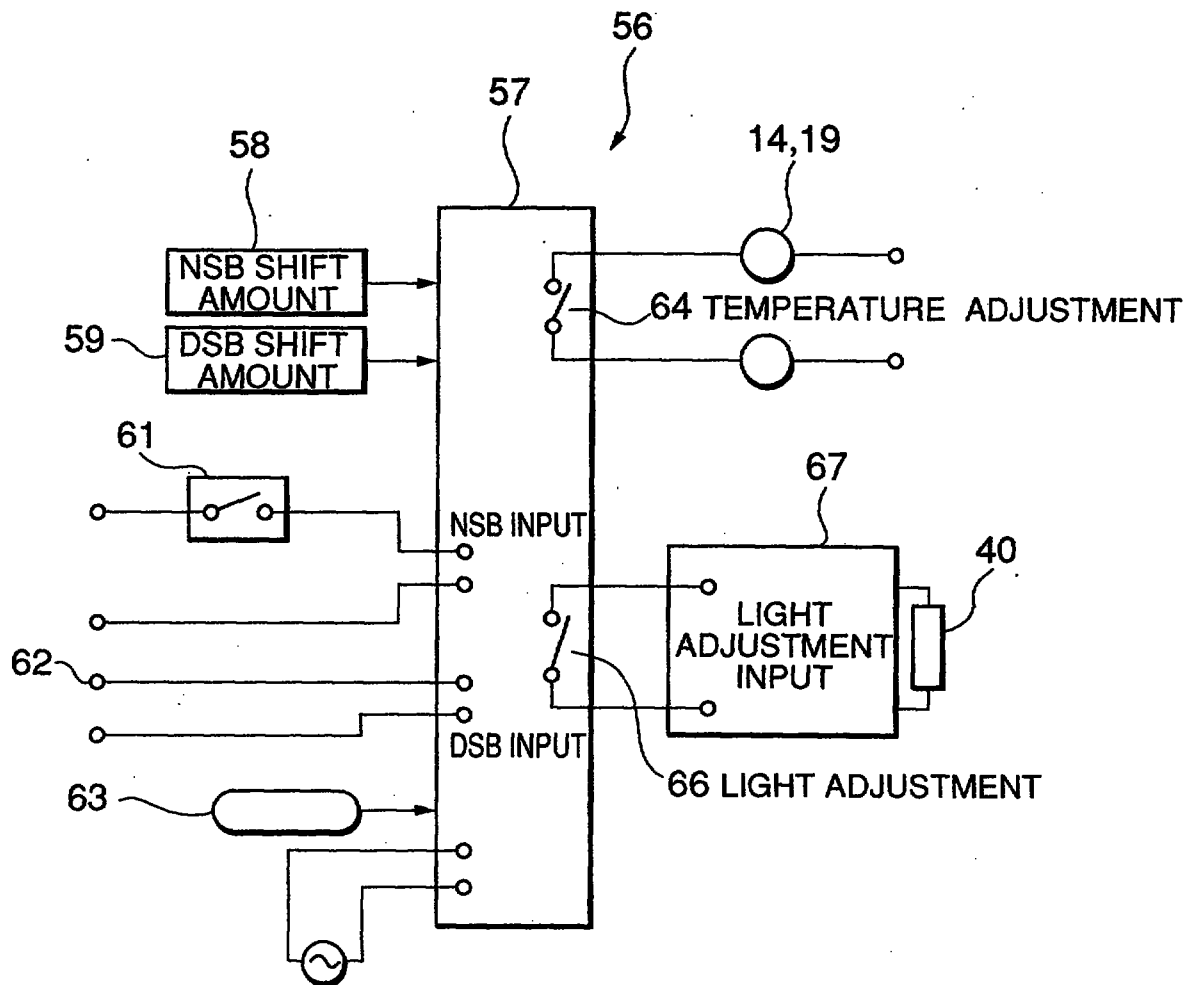


FIG.4

