

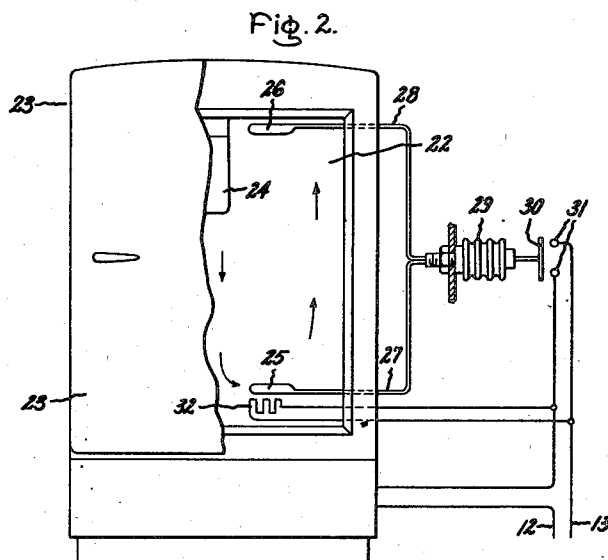
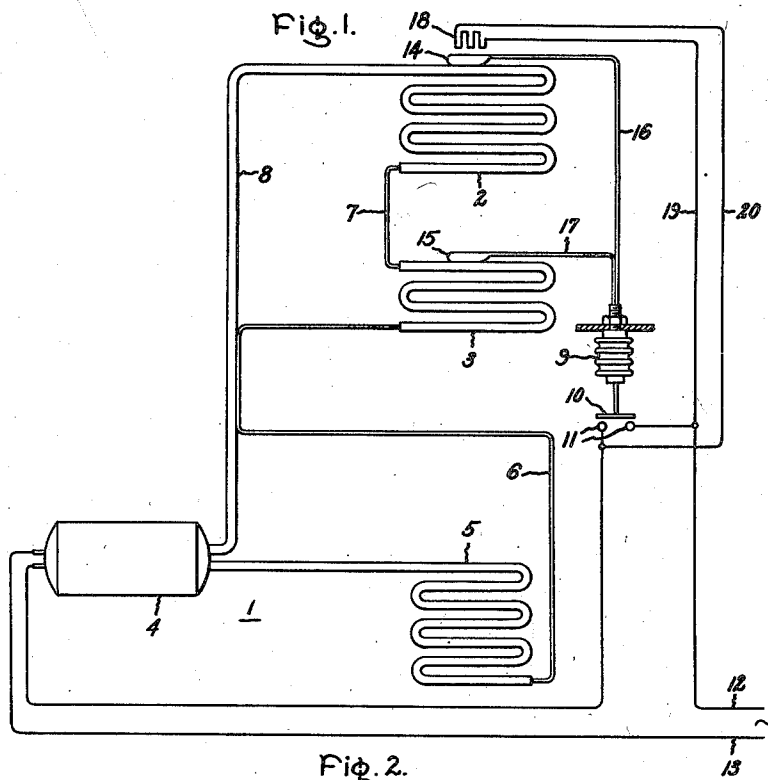
Nov. 21, 1950

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2,531,136

CONTROL ARRANGEMENT FOR REFRIGERATING SYSTEMS

Filed Dec. 28, 1949



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UNITED STATES PATENT OFFICE

2,531,136

CONTROL ARRANGEMENT FOR
REFRIGERATING SYSTEMSLowell M. Kurtz, Erie, Pa., assignor to General
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Application December 28, 1949, Serial No. 135,408

11 Claims. (Cl. 62-4)

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My invention relates to refrigerating systems and more particularly to control arrangements for refrigerating systems.

It is an object of my invention to provide an improved control arrangement for a refrigerating system including two evaporators.

It is another object of my invention to provide an improved arrangement for securing a small differential in control operation.

Further objects and advantages of my invention will become apparent as the following description proceeds and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming part of this specification.

In carrying out the objects of my invention a system is employed including a bellows and two temperature responsive bulbs connected in communication with the bellows. A volatile fluid is provided as a charge in the system. A heater which is energized whenever the refrigerating unit is off is employed to transfer control of the bellows from one bulb to the other.

For a better understanding of my invention reference may be had to the accompanying drawing in which Fig. 1 is a schematic diagram of a refrigerating system including an embodiment of my invention; Fig. 2 shows a modified form of my invention.

Referring to Fig. 1 there is shown a refrigerating system including a condensing unit 1 and two evaporators 2 and 3 all connected in a closed series refrigerant circuit. The condensing unit 1 includes a motor compressor unit housed within a casing 4 and a condenser 5. Liquid refrigerant is supplied from the condensing unit 1 to the evaporator 3 through a restricted tube 6. Refrigerant passes from the evaporator 3 to the evaporator 2 through a second restricted tube 7 which provides a pressure and temperature differential between evaporators 2 and 3. Vaporized refrigerant is withdrawn from the evaporator 3 and returned to the casing 1 through a suction line 8.

The refrigerating system disclosed is adapted for application to a combination refrigerator which includes a compartment for storing frozen foods and a second compartment for storing fresh foods. The evaporator 2 is operated at a low temperature, providing a low temperature zone suitable for the preservation of frozen foods, and the evaporator 3 is operated at a higher temperature, providing a high temperature zone suitable for the preservation of fresh foods. The low temperature evaporator

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2 may operate for example within a range of temperatures in the neighborhood of 0° F. The higher temperature evaporator 3, on the other hand, may operate within a range of temperatures in the neighborhood of 32° F. In order to provide for defrosting of the evaporator 3 during each cycle of operation of the condensing unit the upper limit of the temperature of this evaporator may be about 35° F.

In order to control the operation of the condensing unit and to maintain the proper temperatures of the evaporators 2 and 3 a control system is provided. This control system includes a bellows 9 which actuates a switch 10 to open and close the electrical circuit of the condensing unit at the contacts 11. The motor of the condensing unit is supplied from a source of power through lines 12, 13 connected to the contacts 11. The control system further includes two temperature responsive bulbs 14 and 15 which are connected in communication with the bellows 9 through tubes 16 and 17, respectively. The bulb 14 is positioned adjacent the low temperature evaporator 2 and the bulb 15 is positioned adjacent the higher temperature evaporator 3. The system including the bellows 9, the tubes 16 and 17, and the bulbs 14 and 15 is charged with a volatile fluid. The charge is chosen so that during the operation of the apparatus liquid is always present in one or the other of the bulbs. The bellows 9 is subjected to a pressure which is a function of the temperature of liquid in the bulb 14 or the bulb 15. The pressure which is effective in controlling the bellows is that corresponding to the temperature of the lower temperature bulb. This results from the fact that a higher temperature existing in the warmer bulb does not raise the pressure applied to the bellows since the fluid vaporized by the higher temperature is condensed in the lower temperature bulb, and the pressure applied to the bellows is therefore determined by the lowest temperature to which the fluid is subjected. In normal operation the evaporator 2 is operated at a low temperature in the neighborhood of 0° F. and accordingly the control of the actuation of the bellows 9 depends on the temperature of the bulb 14. The bellows may be arranged, for example, to contract sufficiently to open the switch 10 when the temperature of the evaporator 2, as indicated by the bulb 14, reaches a temperature of say -2° F.

I have provided an arrangement for automatically transferring the control of the bellows from the bulb 14 to the bulb 15 whenever the

switch 10 is opened to stop the operation of the condensing unit. This is accomplished by connecting a resistance element or heater 18 across the contacts 11 through lines 19, 20. The heater 18 is disposed adjacent the temperature responsive bulb 14. During the time that the circuit of the condensing unit is closed through the contacts 11 by the switch 10 a short circuit is provided across the heater 18 and no power is supplied to this heater. However, when the switch 10 is opened as a result of the evaporator 2 and the bulb 14 having reached the predetermined minimum temperature power is supplied from the lines 12, 13 through the motor windings to the heater 18. The heat generated by the heater 18 raises the temperature of the bulb 14 above that of the bulb 15 and, on the basis of the analysis set forth above, the control of the actuation of the bellows 9 is therefore transferred to the bulb 15 and is dependent upon the temperature of the liquid in the bulb 15. The bellows 9 may be arranged to expand sufficiently to close the switch 10 when the temperature of the evaporator 3 and hence of the bulb 15 reaches a predetermined maximum of say 35° F. This temperature is sufficient to effect defrosting of the evaporator 3 during the off period of the condensing unit. The actuation of the switch 10 to close the circuit of the condensing unit at the contacts 11 starts the condensing unit and simultaneously provides a short circuit across the contacts 11, deenergizing the heater 18. The bulb 14 is therefore allowed to cool down to the temperature of the evaporator 2 and, being then at a lower temperature than the bulb 15, the bulb 14 regains control of the actuation of the bellows 9. The condensing unit is then operated until the temperature of the evaporator 2 reaches the predetermined minimum at which time the bellows, under the influence of the bulb 14, opens the switch 10.

It can be seen from the above description that the stopping of the condensing unit is controlled by the temperature of the evaporator 2 through the temperature responsive bulb 14 positioned on this evaporator. The starting of the condensing unit is controlled by the temperature of the evaporator 3 through the bulb 15. The condensing unit is thus started when the temperature of the evaporator 3 reaches a predetermined maximum and the condensing unit is stopped when the temperature of the evaporator 2 reaches a predetermined minimum. The heater 18 is connected so that control is automatically shifted from one bulb to the other coincident with the starting and stopping of the condensing unit.

In Fig. 2 there is illustrated an application of my invention to a refrigerator using only a single evaporator. In this application the control system is employed to secure a small differential between the maximum and minimum temperatures of the air within the food storage compartment of the refrigerator while employing a control mechanism which may have a relatively large differential. Referring to Fig. 2 there is illustrated a refrigerator 21 having a food storage compartment 22, the access opening of which is closed by a door 23. An evaporator 24 is provided in the upper portion of the food storage compartment 22 for cooling that compartment. By way of illustration, the evaporator 24 is positioned toward one side of the compartment 22 so that a natural circulation of air is secured within the compartment in the general direction indicated by the arrows. Thus, warm air rises

along the right-hand side of the compartment, passes over the evaporator 24, and the resultant cool air descends along the left-hand portion of the compartment. Accordingly, the temperature in the lower portion of the compartment is appreciably lower than that in the upper right-hand corner of the compartment. By way of example the temperature in the lower portion of the compartment may be 38° F. while that in the upper right-hand corner may be 45° F. Although an evaporator has been illustrated which is positioned within the compartment 22 at one upper corner thereof, other types of evaporators and other locations thereof could be employed. For example, a full width horizontal type evaporator could be employed in the upper portion of the compartment 22, or a plate type evaporator, or the upper portion of the back of the liner of the compartment 22 could be refrigerated by evaporator tubing secured to the exterior of the liner.

The above difference in temperature between the top and bottom of the compartment 22 is utilized in securing the small differential in the operation of the control. This is accomplished by using a control system similar to that shown in Fig. 1 and positioning one bulb 25 in the lower portion or colder area of the compartment and the other bulb 26 in the upper right-hand corner or warmer area of the compartment. The bulbs 25 and 26 are connected by tubes 27 and 28, respectively, in communication with the interior of the bellows 29. The control system is charged, as in the previous form, with a volatile fluid. The bellows 29 is arranged to actuate a switch 30 which closes a circuit through contacts 31. Power is supplied from a suitable source through lines 12 and 13 and the contacts 31 to a condensing unit (not shown) in the conventional machinery compartment at the lower portion of the refrigerator.

It may be desirable to maintain a differential in the operation of the switch in the order of, for example, 2° F., so as to minimize fluctuation in the box air temperature, that is, the temperature of the air within the food storage compartment 22. It is difficult to provide a mechanism with a differential this small and an ordinary mechanism may have a differential between maximum and minimum temperatures of about 9° F. By the arrangement described it is possible to secure a differential of 2° F. while at the same time employing the same mechanism which normally operates on a differential of 9° F. Thus, as in the arrangement shown in Fig. 1 the bulb 25 which is positioned in the colder portion of the compartment 22 normally controls the movement of the bellows, being at a lower temperature than the bulb 26. The operation of the condensing unit is stopped by the opening of the switch 30 because of the contraction of the bellows 29 when the temperature in the lower portion of the compartment 22 and hence the temperature of the bulb 25 reaches a predetermined minimum. This temperature may be, for example, 38° F. When the switch 30 is opened stopping the operation of the condensing unit a heater 32 connected across the contacts 31 and positioned adjacent the bulb 25 is energized, and the heat supplied from the heater 32 to the bulb 25 raises the temperature of the bulb above that of the bulb 26 and accordingly transfers control of the actuation of the bellows 29 to the bulb 26. The closing of the switch 30 is therefore under the control of the bulb 26 and this switch is closed when the tem-

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perature in the upper right-hand portion of the compartment 22 reaches a predetermined maximum, for example 47° F. The closing of the switch 30 not only starts the condensing unit but deenergizes the heater 32 and, as the bulb 25 cools, control is returned to the bulb 25. Thus, the starting of the condensing unit is controlled by the temperature of the bulb 26 and the stopping of the condensing unit is controlled by the temperature of the bulb 25.

The differential between the temperatures effecting operation of the bellows is 9° and therefore a control mechanism having a 9° temperature differential in the actuation of the switch to open and closed positions may be employed. However, since the normal differential between the temperature of the compartment at the point where the bulb 25 is positioned and at the point where the bulb 26 is positioned is approximately 7° the equivalent of a 2° differential of the operation in the control mechanism is secured. Thus, considering the fact that the condensing unit is stopped at the time when the temperature in the area of the bulb 25 reaches 38° F. it will be realized that the temperature in the area of the bulb 26 at this time is about 45° F. Since the bulb 26 effects starting of the condensing unit when the temperature rises to 47° F. the increase in temperature within the box during the off period is limited to 2° F. Were a single bulb employed responsive to box air the fluctuation in the box air temperature would, of course, be approximately 9° F. It can be seen, therefore, that the use of the control arrangement of my invention reduces considerably the fluctuation of the temperature within the compartment 22.

While I have shown and described specific embodiments of my invention other applications will occur to those skilled in the art and I intend by the appended claims to cover all modifications within the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A refrigerating system including a condensing unit, a control system for starting and stopping said condensing unit under predetermined maximum and minimum temperature conditions, said control system including a bellows and two temperature-responsive bulbs in communication with said bellows, said system having a volatile fluid therein, the first of said bulbs being disposed in a cold zone and the second of said bulbs being disposed in a warmer zone, a heater disposed adjacent said first bulb, and means actuated by said bellows for stopping said condensing unit and simultaneously energizing said heater whereby control of said bellows is transferred from said first bulb to said second bulb.

2. A refrigerating system including a condensing unit, a control system for starting and stopping said condensing unit under predetermined maximum and minimum temperature conditions, said control system including a bellows and two temperature-responsive bulbs in communication with said bellows, said system having a volatile fluid therein, the first of said bulbs being disposed in a cold zone and the second of said bulbs being disposed in a warmer zone, a heater disposed adjacent said first bulb, and means actuated by said bellows for stopping said condensing unit and simultaneously energizing said heater whereby control of said bellows is transferred from said first bulb to said second bulb, said means also being actuated by said bellows for starting said condensing unit and simultaneously deenergizing

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said heater to transfer control of said bellows from said second bulb to said first bulb.

3. A refrigerating system including a condensing unit, a control system for starting and stopping said condensing unit under predetermined maximum and minimum temperature conditions, said control system including a bellows and two temperature-responsive bulbs in communication with said bellows, said system having a volatile fluid therein, the first of said bulbs being disposed in a cold zone and the second of said bulbs being disposed in a warmer zone, an electrical circuit including a pair of contacts for supplying power to said condensing unit, and means for starting said condensing unit in response to a condition of said second bulb and stopping said condensing unit in response to a condition of said first bulb, said means including a switch actuated by said bellows and cooperating with said contacts and a heater positioned across said contacts and disposed adjacent said first bulb.

4. A refrigerating system including a condensing unit, a control system for starting and stopping said condensing unit under predetermined maximum and minimum temperature conditions, said control system including a bellows and two temperature-responsive bulbs in communication with said bellows, said system having a volatile fluid therein, the first of said bulbs being disposed in a cold zone and the second of said bulbs being disposed in a warm zone, an electrical circuit including a pair of contacts for supplying power to said condensing unit, a switch actuated by said bellows for engaging said contacts to close said circuit, and a heater disposed adjacent said first bulb and connected across said contacts, said switch simultaneously deenergizing said condensing unit and energizing said heater for transferring control of said bellows from said first bulb to said second bulb.

5. A refrigerating system including a condensing unit, a control system for starting and stopping said condensing unit under predetermined maximum and minimum temperature conditions, said control system including a bellows and two temperature-responsive bulbs in communication with said bellows, said system having a volatile fluid therein, the first of said bulbs being disposed in a cold zone and the second of said bulbs being disposed in a warm zone, a circuit including a pair of contacts for supplying power to said condensing unit, a switch actuated by said bellows for engaging said contacts to close said circuit, and a heater disposed adjacent said first bulb and connected across said contacts, said switch simultaneously deenergizing said condensing unit and energizing said heater for transferring control of said bellows from said first bulb to said second bulb, said switch simultaneously energizing said condensing unit and deenergizing said heater for transferring control of said bellows from said second bulb to said first bulb.

6. A refrigerating system including a condensing unit, a low temperature evaporator and a higher temperature evaporator connected in closed refrigerant circuit, a first temperature-responsive bulb disposed on said low temperature evaporator, a second temperature-responsive bulb positioned on said higher temperature evaporator, a bellows in communication with both of said bulbs, said bellows and said bulbs being charged with a volatile fluid, a heater disposed adjacent said first bulb, and a switch actuated by said bellows for stopping said condensing unit when said low temperature evaporator reaches a predeter-

mined minimum temperature, said switch simultaneously effecting energization of said heater for transfer control of said bellows to said second bulb.

7. A refrigerating system including a condens- 5
ing unit, a low temperature evaporator and a
higher temperature evaporator connected in
closed refrigerant circuit, a first temperature-
responsive bulb disposed on said low temperature 10
evaporator, a second temperature responsive bulb
positioned on said higher temperature evapo-
rator, a bellows in communication with both of
said bulbs, said bellows and said bulbs being
charged with a volatile fluid, a heater disposed
adjacent said first bulb, and a switch actuated 15
by said bellows for stopping said condensing unit
when said low temperature evaporator reaches a
predetermined minimum temperature, said switch
simultaneously effecting energization of said
heater for transferring control of said bellows to 20
said second bulb, said switch being actuated
by said bellows for starting said condensing unit
when said higher temperature evaporator reaches
a predetermined maximum temperature, said
switch simultaneously effecting deenergization of 25
said heater to return control of said bellows to
said first bulb.

8. A refrigerating system including a condens-
ing unit, a low temperature evaporator and a
higher temperature evaporator connected in 30
closed refrigerant circuit, said higher tempera-
ture evaporator operating on a defrosting cycle,
a first temperature-responsive bulb disposed on
said low temperature evaporator, a second tem-
perature-responsive bulb positioned on said high-
er temperature evaporator, a bellows in commu-
nication with both of said bulbs, said bellows and
said bulbs being charged with a volatile fluid,
a heater disposed adjacent said first bulb, and a
switch actuated by said bellows for stopping said
condensing unit when said low temperature evap- 35
orator, reaches a predetermined minimum tem-
perature, said switch simultaneously effecting en-
ergization of said heater for transferring control
of said bellows to said second bulb, said switch
being actuated by said bellows for starting said
condensing unit when said higher temperature
evaporator reaches a predetermined maximum
temperature sufficiently high to insure defrost-
ing of said higher temperature evaporator, said
switch simultaneously effecting deenergization of 40
said heater to return control of said bellows to
said first bulb.

9. A refrigerator including a food storage com-
partment having a colder area and a warmer
area therein, a refrigerating system including an
evaporator for cooling said compartment and a
condensing unit, a control system for starting
and stopping said condensing unit under pre-
determined maximum and minimum temperature
conditions, said control system including a bel-
lows and two temperature-responsive bulbs in
communication with said bellows, said system
having a volatile fluid therein, the first of said
bulbs being disposed in the colder area of said
compartment and the other of said bulbs being
disposed in the warmer area of said compart-
ment, a heater disposed adjacent said first bulb,
and means actuated by said bellows for stopping
said condensing unit and simultaneously ener-
gizing said heater whereby control of said bel-
lows is transferred from said first bulb to said
second bulb.

10. A refrigerator including a food storage
compartment having a colder area and a warmer
area therein, a refrigerating system including an
evaporator for cooling said compartment and a
condensing unit, a control system for starting
and stopping said condensing unit under prede-
termined maximum and minimum temperature
conditions, said control system including a bel-
lows and two temperature-responsive bulbs in
communication with said bellows, said system
having a volatile fluid therein, the first of said
bulbs being disposed in the colder area of said
compartment and the other of said bulbs being
disposed in the warmer area of said com-
partment, an electrical circuit including a pair
of contacts for supplying power to said condens-
ing unit, and means for starting said condens-
ing unit in response to a condition of said sec-
ond bulb and stopping said condensing unit in
response to a condition of said first bulb where-
by a small differential in operation of the con-
trol system is achieved and fluctuation of tem-
perature within said compartment is minimized,
said means including a switch actuated by said
bellows and cooperating with said contacts and
a heater positioned across said contacts and dis-
posed adjacent said first bulb.

11. A refrigerator including a food storage
compartment, a refrigerating system including
an evaporator for cooling said compartment and
a condensing unit, said evaporator being disposed
at the upper portion of said compartment and
inducing a circulation of air within said com-
partment whereby a colder area is provided at
the bottom of said compartment and a warmer
area in the upper portion of said compartment,
a control system for starting and stopping said
condensing unit under predetermined maximum
and minimum temperature conditions, said con-
trol system including a bellows and two temper-
ature-responsive bulbs in communication with
said bellows, said system having a volatile fluid
therein, the first of said bulbs being disposed at
the bottom of said compartment in said colder
area and the other of said bulbs being disposed
in the upper portion of said compartment in said
warmer area, an electrical circuit including a
pair of contacts for supplying power to said con-
densing unit, and means for starting said con-
densing unit in response to a condition of said
second bulb and stopping said condensing unit
in response to a condition of said first bulb
whereby a small differential in operation of the
control system is achieved and fluctuation of
temperature within said compartment is min-
imized, said means including a switch actuated
by said bellows and cooperating with said con-
tacts and a heater positioned across said con-
tacts and disposed adjacent said first bulb.

LOWELL M. KURTZ.

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