

June 17, 1930.

L. BRUEHL ET AL

1,764,194

CONTROLLING DEVICE FOR HEAT TRANSFERENCE IN REFRIGERATORS

Filed April 4, 1927

3 Sheets-Sheet 1

Fig. 1.

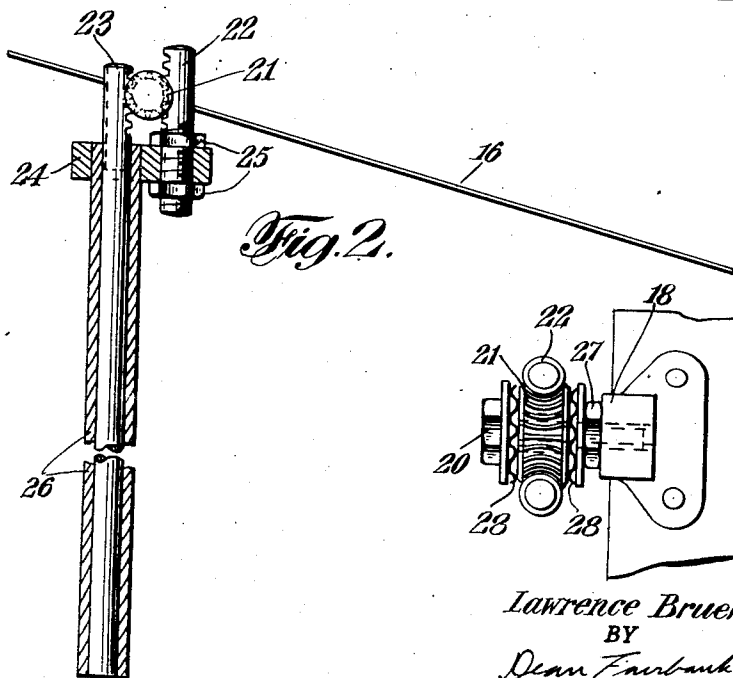
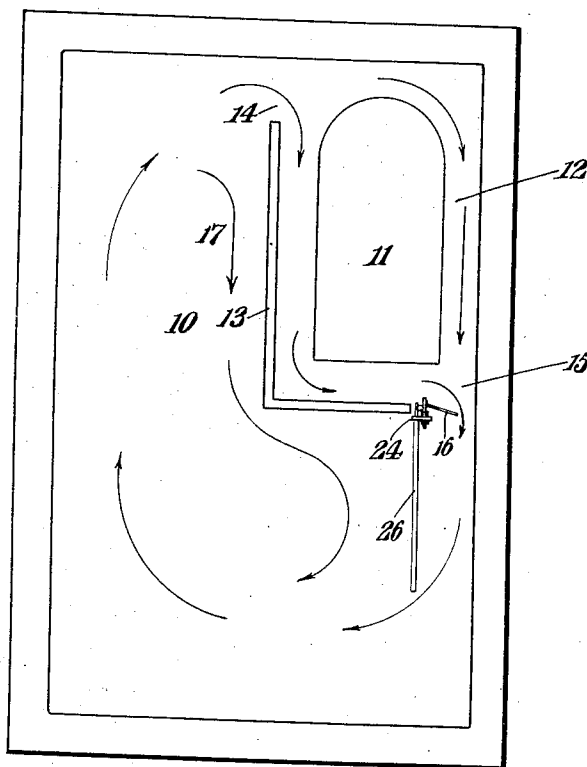


Fig. 2.

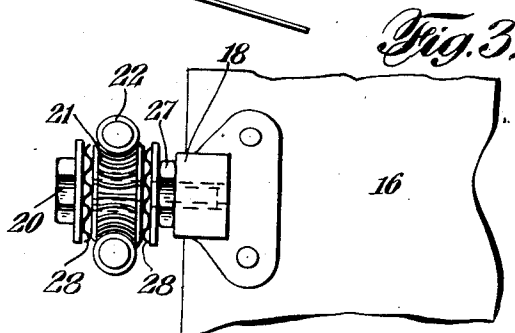


Fig. 3.

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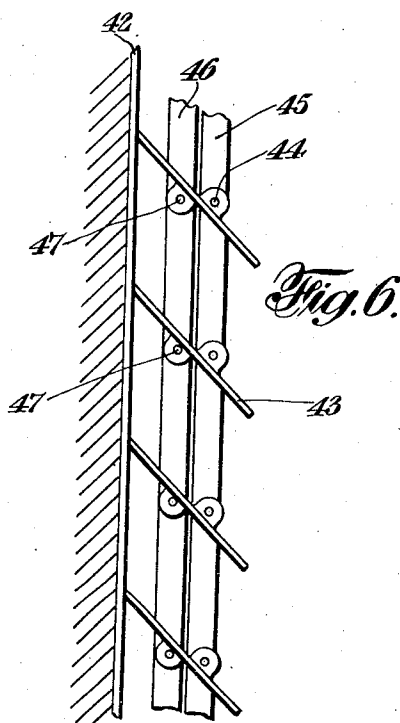
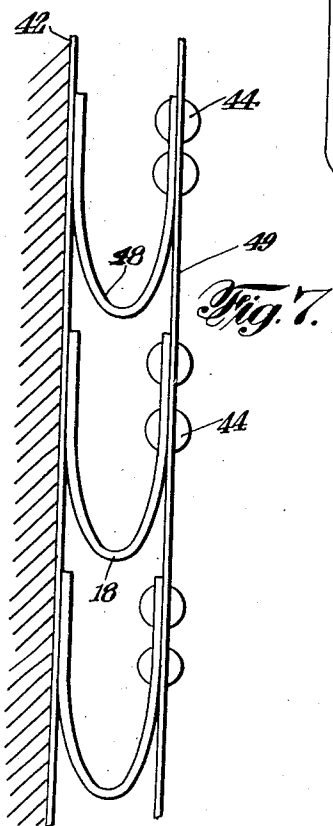
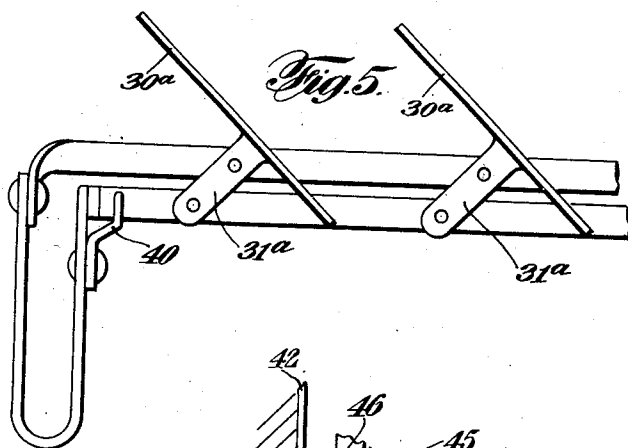
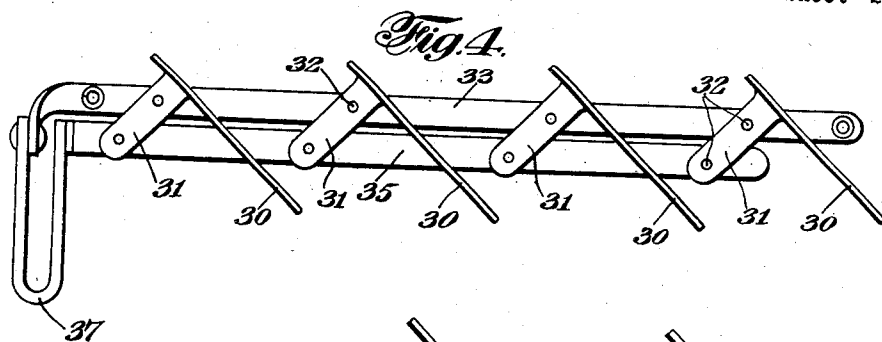
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CONTROLLING DEVICE FOR HEAT TRANSFERENCE IN REFRIGERATORS

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3 Sheets-Sheet 2



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CONTROLLING DEVICE FOR HEAT TRANSFERENCE IN REFRIGERATORS

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3 Sheets-Sheet 3

Fig. 8.

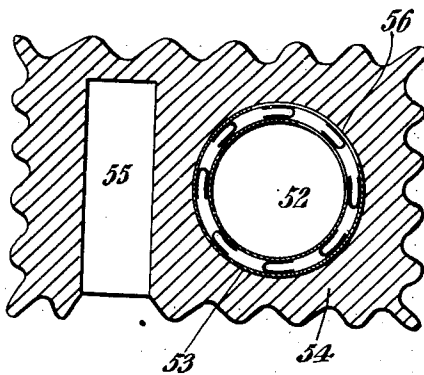


Fig. 9.

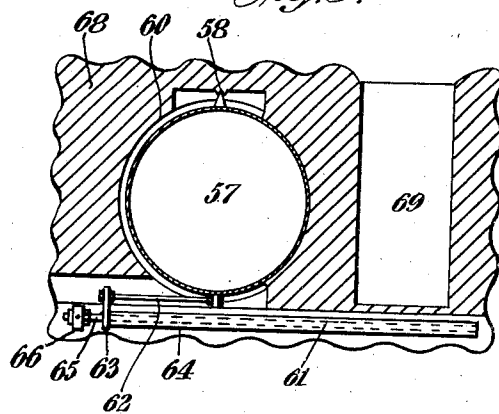


Fig. 10.

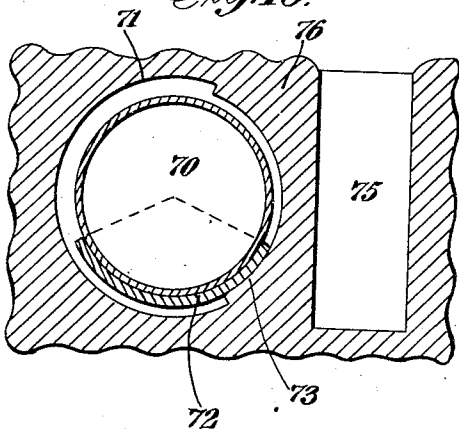
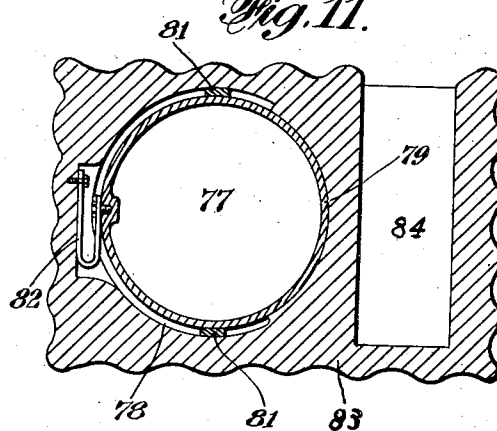


Fig. 11.



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UNITED STATES PATENT OFFICE

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CONTROLLING DEVICE FOR HEAT TRANSFERENCE IN REFRIGERATORS

Application filed April 4, 1927. Serial No. 180,749.

This invention relates to means for regulating the temperature of a refrigerator or cooling chamber containing a cooling element such as the evaporator of a refrigerating machine or an element cooled by brine.

If the doors of a refrigerator remain closed for a long time and consequently only a small amount of heat is admitted to the interior thereof, there will be a tendency for the temperature therein to fall to too low a level. This condition is especially likely to exist if the outside temperature is relatively low. It is not desirable to have the temperature in the refrigerator too low inasmuch as food therein might be frozen or made too cold for table use.

The main object of our invention is to provide an automatic temperature control for the refrigerator, which control is located entirely within the refrigerator and has no communication with the outside thereof.

A clear idea of the invention may be obtained by considering the temperature conditions and the path of the air currents in refrigerators. The transfer of heat between the cooling element or evaporator and the air is effected by conduction and radiation and the air around the evaporator is cooled and then flows down due to its greater specific gravity and is replaced by warmer air rising to the top of the compartments, thus causing circulation of the air past the cooling element. Assuming the evaporator temperature to be constant, the force tending to cause circulation of the air depends upon the average temperature in the refrigerator and would be zero if the interior temperature of the refrigerator chamber and the temperature of the evaporator were the same. Such a condition is never reached in a continuously working refrigerating machine except in the event that the refrigerating machine stops. In an absorption machine of the intermittent type said force tending to cause circulation of the air goes down to zero and even becomes negative during the boiling period of the machine.

The force tending to produce circulation of the air is not only a function of the temperature as already mentioned but is also

a function of the amount of heat transmitted through the air of the refrigerator and between the evaporator and the outside of the refrigerator, such functions being interdependent. This force depends also on the outside or room temperature in that a high outside or room temperature increases said force and a low outside temperature decreases said force assuming that the evaporator temperature is constant. This would mean that the temperature in the refrigerator would vary automatically to a predetermined value without using any control, and this result might be obtained by structural means only if it were possible to keep the evaporator at a constant temperature. It is, however, practically impossible to obtain such a result by simple means because the temperature of the evaporator is influenced by a number of outside factors which vary considerably and it is therefore particularly necessary to provide other and automatic means to control such force tending to produce circulation of the air.

Our invention may be carried out in different ways, as, for example, by providing automatic means for varying the heat transmission surface of the evaporator, or by varying the effective size of the air flow passage.

Other objects and advantages will be pointed out hereinafter or will be apparent from a consideration of the embodiments illustrated in the accompanying drawings. It is to be understood that these drawings are to be considered in an illustrative rather than in a limiting sense.

In the drawings:

Fig. 1 is a diagrammatic view illustrating a refrigerator embodying one form of the invention;

Fig. 2 is a detail view, partly in section, of the structure shown in Fig. 1;

Fig. 3 is a detail view of the connection between a wing or vane and the wing-shift- ing means;

Figs. 4 to 11 are views illustrating other forms of the invention.

In Fig. 1, the invention is illustrated as applied to a refrigerator box or compart-

ment 10 which contains in the upper right hand portion thereof a cooling element 11 which may be an evaporator of a refrigerating apparatus of which the other parts are outside of the compartment 10. The cooling element may be spaced from the wall of the box 10 and may be positioned within a compartment 12 formed by a baffle 13 having upright and horizontal portions spaced from the box 10 so as to provide an entrance 14 at the top of the compartment 12 and an opening or exit 15 beneath said cooling element 11. Warm air in the refrigerator rises to the top thereof at the left of the baffle 13, passes through said entrance 14, down around the cooling element 11 by which it is cooled, and then due to its greater specific gravity passes out through the opening 15 into the lower part of the box or compartment 10. The cold air from the cooling element 11 may take up heat from objects in the lower part of the refrigerator, rise again at the left of the baffle 13, and go through the same cycle as before.

Continued circulation of the air through the openings 14 and 15 may result in reducing the temperature in the box 10 to too great an extent and according to the present invention this condition may be prevented by automatic control means located in the box 10. To this end there is provided at one edge of the opening 15 a movable wing or baffle 16 which by suitable means is swung to decrease or stop the flow of air through the compartment 12 when the temperature becomes too low in the box and is swung to permit or increase the flow when the temperature becomes too high. When the current of air through the compartment 13 is shut off, the air in said compartment is substantially dead and exerts a higher resistance to the transfer of heat from the cooling element 11 to the total quantity of air in the box 10. Obviously the baffle 13 may be connected with the evaporator itself or may be attached to the refrigerator box.

It is essential, however, that the coefficient of heat transmission be changed considerably to cause the cooling effect of the evaporator on the refrigerator box to change in such a manner that the temperature will have a rising tendency or at least keep constant and not lower further. When the opening 15 is closed, the air is forced to circulate outside of the compartment 12 as indicated by the downwardly extending arrows 17, and the cooling effect of the element 11 is exerted through the air space in the compartment 12 and through the insulating baffle 13 which must have a certain heat leakage to avoid too rapid oscillation of the control and to obtain smoother operation.

If the entire heat flow from the contents of the refrigerator box to the evaporator 11 through the baffle 13 is greater than the flow of heat from the outside to the part of the

refrigerator outside of the baffle 13, the flow from the outside to the evaporator compartment need not be considered because it would have no influence upon the food compartment as the temperature would sink in any event, but if said flow of heat from the outside of the compartment 12 to the evaporator is less than the flow coming from the outside at the temperature at which the opening 15 has been closed, the opening 15 must be opened again. The extremely cold air in compartment 12 then flows to the lower part of the refrigerator box 10 and the opening 11 is again closed. If the control means is especially sensitive, that is, if a difference of a few degrees in temperature is sufficient to open or close the opening 15, the control will make oscillations which will be avoided if both flows of heat are about the same, in other words, if the resistance in baffle 13 is about the same as the resistance in the walls of the refrigerator box.

One form of automatic controlling means for the movable baffle 16 is indicated in Fig. 1, and in greater detail in Figs. 2 and 3. The baffle 16 is provided at one edge with a member 18 having an internally threaded socket into which is fitted a screw 20 provided with a head suitable for actuation by a wrench. Mounted on the shaft or screw 20 is a pinion 21 having a peripheral groove in which engage on opposite sides two rods 22 and 23 having rack bar portions. One is threaded into a member 24 and adjustably locked therein by nuts 25. Fixed in said member 24 is a casing or tube 26 which guides the rod 23. The rod 23 extends into the tube 26 and is secured thereto at the lower end by suitable means such as solder. The rod 23 and the tube 26 are of metal and with such different coefficients of heat expansion that, as the temperature rises, the upper end of the rod 23 moves out of the upper end of the tube and swings the baffle or wing 16 towards its open position. As the temperature falls, the rod 23 will contract more rapidly than the tube or casing 26 and the wing 16 will be moved towards the closed position.

If the pinion 21 were held absolutely against rotation with reference to the pivot screw 20 it would be very difficult to adjust the control after installation thereof. Such difficulty is, however, eliminated by the arrangement shown in Fig. 3. The screw 20 is held in the member 18 against loosening by a lock nut 27 and to hold the worm gear 21 yieldably in position spring washers 28 are placed on opposite sides of the worm gear 21. This arrangement enables easy rotational adjustment between the wing 16 and the pinion 21, inasmuch as the wing and pinion are held together frictionally.

In the embodiment of the automatic control illustrated in Fig. 4, there are a number of wings or baffles 30 which may be operated

simultaneously and are provided with arms 31 pivoted at 32 to a supporting bar 33 held in position by suitable means, such as screws. A rod or bar 35 is mounted parallel to the bar 33 and is pivoted at points 36 to said arms 31. A U-shaped bi-metallic strip 37 has its ends connected to the ends of bars 33 and 35. It may be riveted to the bar 33 and merely abut against the bar 35. The pivots 32 are so located in respect to the centers of gravity of the wings 30 that the wings tend to force the rod 35 to the left against the end of the thermostatic or bimetallic strip 37 which responds to temperature changes in the refrigerator.

The bi-metallic strip 37 is so arranged that an increase in the temperature of the box acts to close the open end thereof thus permitting the wings 30 to drop down, and a decrease in temperature acts to spread apart the ends of the U-shaped member and thereby to raise said wings 30 to effective or closing position. It will be apparent that for definite intermediate temperature the wings will take definite positions intermediate their open and closed positions thus providing a definite cross-section for the passage of air through the openings between the wings. The member 37 may be so arranged that at a certain predetermined temperature of the box the wings cooperate with each other to close the openings, the lower end of each wing to the left coming in contact with the upper end of each wing to the right.

The wings of the control device illustrated in Fig. 4 open and close gradually in response to changes in temperature. In Fig. 5 however, there is disclosed a structure by which a snap action in opening and closing the wings 30 is obtained. This control is substantially the same as that illustrated in Fig. 4 except that the wings are normally in raised position and may be swung downwardly to closed position. In this arrangement wings 30^a are provided with downwardly projecting arms 31^a pivoted at 32^a to bars 33 and 35. One end of the bi-metallic member 37 is provided with a hook or lug 40 having lost motion connections with the end of the rod 35. When the temperature decreases the U-shaped member opens at its top and until the pivots of the arms 31^a on the rod 35 pass beneath the pivots on the rod 33 the wings will be overbalanced and fall to closed position. They remain closed until a change in temperature in the reverse direction moves the pivots beneath the centers of gravity of the wings and a slight further movement of the bar 35 causes a snap action to full open position. When the wings are thus opened, the temperature of the box will start to rise. The play between the parts may, however, be so arranged that the wings remain closed during a rise of temperature to a certain number of degrees, say 45°, the wings then

opening gradually and the dead center position being passed at a higher temperature, say 50°, the wings then snapping to their limiting positions to open completely the space controlled thereby.

The snap action just described has the same effect as the heat leakage of baffle 13 in Fig. 1, that is, of reducing the operation of the control as much as possible. This means that according to the above temperatures which are given merely for example, the control would not work at all between 38° and 45° Fahrenheit as the temperature increases, and between 50° and 43° as the temperature decreases.

In the hereinafter described controls, the coefficient of heat transmission is regulated but this regulation is valuable principally in the limiting conditions of the control, that is, when the control is closed or opened. When the control is closed the coefficient of heat transmission is based upon the influence of the air space in compartment 12 and of the baffle 13 including all surface resistance. When the control is opened the surface resistance of the evaporator determines the coefficient of heat transmission. If the snap action is employed, it may be possible to control the coefficient of heat transmission only when the control has only two positions, either open or closed. Such a control is not, however, of special interest in that it would require additional members and would be more expensive.

The controls illustrated in Figs. 1 to 5 are effective in all of the intermediate positions as well as for the end positions. When the cross-section of the air current is diminished by the control the air is forced to remain longer in compartment 12 so that the air temperature sinks to a lower degree. The decrease of the air temperature also decreases the difference between the air temperature and the evaporator temperature so that a smaller amount of heat passes from the air to the cooling element or evaporator, thus controlling the temperature of the air indirectly. The decrease of temperature in the refrigerator compartment which affects the thermostatic control serves to decrease the air temperature in compartment 12 relatively more, so that the flow of cold from or of heat to the evaporator is diminished, that is, the control interferes with the velocity of air circulation and thus obtains the desired effect.

The regulation of temperature in the refrigerator box may also be controlled by enlarging or diminishing the heat transferring surface of the cooling device or evaporator. One arrangement for obtaining this result is illustrated in Fig. 6 in which there is shown a wall 42 of a cooling unit. Wings 43 of heat conducting material are pivoted at 44 on a fixed bar 45 to be swung to and from contact with the wall 42 by means of a

bar 46 parallel to the bar 45 and pivoted at 47 to the wings 43. The movement of the wings 43 to and from contact with the wall 42 may be effected by suitable thermostatic means such, for example, as disclosed in Figs. 4 and 5. When the temperature of the box decreased below a certain point, the bar 46 is shifted to move all of the wings 43 away from the wall 42, the heat transfer taking place then through a minimum surface only, in other words, the surface of the wall 42. After the box temperature has risen to a predetermined degree the wings 43 will again be moved into contact with the wall 42 and the heat transferring area will be increased by addition of the area of the wings 43 to that of the wall 42. The wall 42 may be cooled by direct contact with liquid refrigerant or brine or any other medium between the evaporator or cooling element and the wall 42. The heat transfer between the cooling element and the air in the refrigerator box, is obtained by the wall 42.

In Fig. 7 there is shown an arrangement adapted for the same purpose as the arrangement disclosed in Fig. 6 but in which U-shaped bi-metallic strips 48 are secured to a second housing 49 outside of the wall 42 of the cooling element. With this arrangement a decrease in box temperature causes withdrawal of bi-metallic strips from the surface of the wall 42 so that the heat transferring surface is diminished. A suitable increase in box temperature causes the thermostatic strips 48 to contact again with the surface of the cooling wall 42, thereby increasing the surface through which heat transfer takes place. The bimetallic strips 48 may be so adjusted that at a certain temperature, say 38° Fahrenheit, they will move out of contact with the surface of the cooling element. At all temperatures below this critical temperature the strips 48 will be out of contact with the wall 42, and also at temperatures above 38° Fahrenheit the strips will be in good thermal contact with the surface of the wall 42. Special care must be taken that in the arrangements illustrated in Figs. 6 and 7 the shiftable members be kept from freezing tight to the wall of the cooling element. In accordance with the construction shown in Fig. 7 it may be arranged so that the strips move constantly to and from the wall 42 of the cooling element thus tending to prevent such freezing action. Figs. 6 and 7 are top views and it will be seen that the air as cooled passes freely downward between the fins or wings 43 in one case and the bi-metallic strips 48 in the other from the upper to the lower part of the cooling element.

Fig. 8 illustrates an arrangement which is circular instead of straight as in Figs. 6 and 7 and which differs from Fig. 7 in that the thermostatic metal strips are in dead air spaces, thus substantially eliminating the

danger of the freezing of the strips tight to the walls. In this form, a cooling element or evaporator 52 is separated by a dead air space from an outer casing 53 which may be enclosed in any suitable medium 54 through which the cooling effect may be transmitted to a compartment 55 or to a room. The medium 54 may consist of brine in a tank or may be a block of aluminum which has high thermal conductivity, and the compartment 55 may be used for any articles to be cooled or for ice trays. Supported on the casing 53 and inside thereof are U-shaped thermostatic metal strips 56. When the temperature of the medium 54 falls to a certain point, the strips 56 are retracted from the cooling element 52 so that the cooling effect transmitted to the casing 53 is considerably decreased inasmuch as the transfer of heat or cold must pass between the high resistance of the dead air between the outer and inner casings. When on the other hand the temperature rises to a certain point the thermostatic strips 56 again contact with the casing of the evaporator 52 and the cooling effect is increased. As a result of the fact that the air between the outer casing 53 and the cooling element 52 is substantially still or dead, no condensation from humid air settles in this space and consequently there is no danger that the thermostatic strips will freeze to the cooling element 52.

In Figs. 9, 10 and 11 the same desired result is obtained by different arrangements in which the cooling element or evaporator may be brought into contact to a greater or less extent with the wall of an outer casing or removed entirely from contact therewith to vary the amount of heat transference taking place through the wall of the outer casing.

In Fig. 9, the evaporator or cooling element 57 is provided at one side with a projection 58 fulcrumed in a notch of an outer casing 60 and is connected at its opposite side with a thermostatic element 61 by which it is moved back and forth about its fulcrum at said notch. At one side the outer casing 60 has a portion of the same curvature as the cooling element 57 and at the other side has a portion of greater length and of a curvature of greater radius than the cooling element so that the cooling element upon swinging in one direction will be brought into contact with and fit in the portion of the same curvature therewith but when swung away therefrom it may be held out of contact with the wall of the casing 60. The thermostatic element 61 includes a rod 62 attached to the cooling element 57 at the opposite side from the projection 58 and also connected with a member 63 secured to a tube 64 attached at its other end to a rod 65 having a slidable fit therein. This rod 65 has a different coefficient of heat expansion from the tube 64 and is adjustably secured at its outer end to a fixed lug 66 by means of nuts

threaded on the rod 65 at opposite sides of the lug 66. The casing 60 is surrounded by a suitable medium 68 through which the cooling element may cool the material in a room or compartment 69. The parts are so arranged and the material of the tube 64 and the rod 65 is such that as the temperature increases above a certain point the cooling element 57 will be swung into contact with the casing 60, and that when the temperature falls to a sufficient extent the cooling element 57 will be moved away from the outer casing 60.

thereby increase the heat-transferring surface of said cooling element.

2. In refrigerating apparatus, a cooling element having a heat conducting wall, a heat conducting wall around the first-mentioned wall and enclosing an air space, bimetallic means attached to one of said walls and responsive to increase of temperature to connect said walls to affect the cooling effect at the outer wall, and responsive to decrease of temperature to disconnect said walls.

3. In refrigerating apparatus, a cooling element having a heat conducting wall, a brine chamber including a second heat conducting wall enclosing an air space around said cooling element and separating said cooling element from said first-mentioned wall, thermostatic means for making and breaking a thermal connection through said air space and between said walls, and a container for matter to be cooled by said brine.

4. In refrigerating apparatus, a cooling element having a peripheral wall, a casing around said cooling element and having a wall spaced from said peripheral wall, and thermostatic means responsive to changes of temperature for thermally connecting or disconnecting said walls.

5. A container having a heat-transferring wall, heat-conducting baffles extending longitudinally of said container and movable into contact with the wall thereof to increase the heat-transferring surface and to provide separate air spaces longitudinally of said container.

6. In combination, a cooling element having a wall, a heat conducting wall spaced therefrom and parallel thereto, and a plurality of thermostatically operated members for making or breaking thermal connection between said walls.

7. In combination, a cooling element having a substantially cylindrical peripheral wall, a heat radiating wall concentric to and spaced from said first mentioned wall, and an annular series of thermostatically operated members for making or breaking thermal contact between said walls.

8. In combination, a cooling element having a substantially cylindrical peripheral wall, a heat radiating wall concentric to and spaced from said first mentioned wall, and an annular series of substantially U-shaped thermostatic elements arranged in an annular series between said walls, and each secured to one wall and adapted to make or break thermal contact with the other wall.

9. In combination, a cooling element having a cylindrical peripheral wall, a brine chamber encircling said cooling element, and thermostatic means for effecting thermal connection between said cooling element and said brine chamber.

10. In combination, an evaporator for producing cooling effect and having a peripheral

As shown in Fig. 10, the cooling element 70 is mounted within and spaced from the walls of an outer casing 71 of which the casing has one portion 73 of a certain radius larger than the radius of the cooling element and another part of still greater radius. Between the cooling element 70 and the casing is a conducting member or segment 72 contacting with the outside of the cooling element 70. This segment may be moved into greater or less contact with the portion 73 of the casing 71 or may be moved entirely out of contact therewith. In this form the cooling element 70 and outer casing 71 as well as a refrigerating room or compartment 75 are positioned within a suitable medium 76 through which the cooling of the room or a compartment 75 may be effected. The rotation of the cooling element 70 may be effected by any of the thermostatic devices used in connection with the other embodiments of the invention.

In the form shown in Fig. 11, a cooling element 77 lies within a casing 78 having a smaller portion 79 of the same radius as the outer wall of the cooling element 77 and a larger portion 80 of a greater radius. In this form, however, the cooling element 77 is slidably mounted between blocks or members 81 for movement to and from the casing portion 79 and this movement is effected by means including a U-shaped thermostatic strip 82 interposed between the casing 78 and the cooling element 77 so that upon increase of temperature at the thermostatic strip 82 the cooling element 77 will be moved into contact with the portion 79 of the casing 78 and upon decrease of temperature to a certain extent the cooling element 77 will be withdrawn from contact with the part 79 of the casing 78 thus controlling the cooling effect transmitted through a medium 83 to a room or chamber 84.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. In refrigerating apparatus, a cooling element having a heat conducting wall member, an auxiliary heat conducting member spaced from said wall member, and a bimetallic strip mounted on one of said members and responsive to increase of temperature to engage the other of said members and

5 wall, a heat conductor encircling said evaporator, and a thermostatically operated movable member for varying the thermal connection between the evaporator and the heat conductor.

11. In combination, an evaporator for producing cooling effect and having a peripheral wall, a heat conductor encircling said evaporator, and a thermostatically operated movable member disposed between said evaporator and said conductor for varying the rate of heat transfer from one to the other.

10 Signed at 20 Grand Ave., Brooklyn in the county of Kings and State of New York this first day of April, 1927.

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LUDWIG REICHERT.

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