Aug. 10, 1937. G. H. MEINZER 2,089,566

BOTTOM ICING REFRIGERATOR

Filed July 1, 1935 4 Sheets-Sheet 1

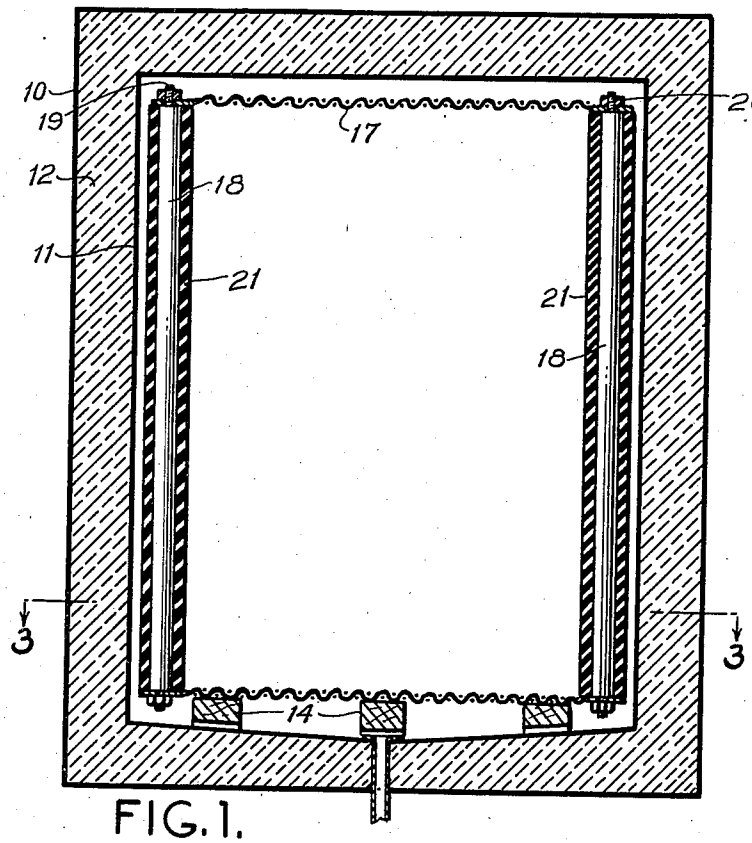


FIG. 1.

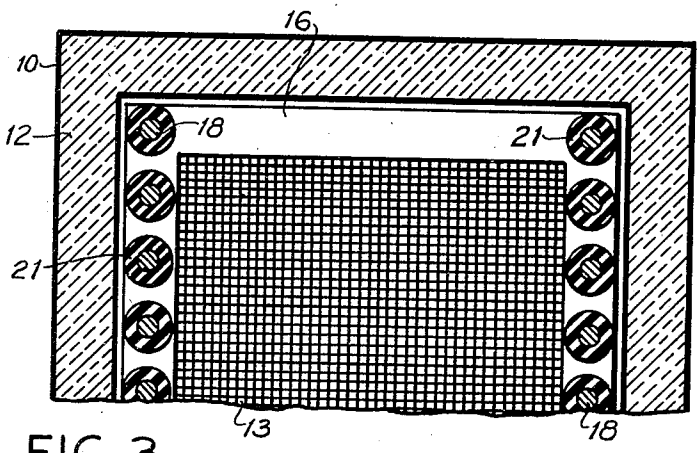


FIG. 3.

INVENTOR.
GOTTHOLD HARRY MEINZER
BY
Paul W. Pritchard.
ATTORNEY.

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BOTTOM ICING REFRIGERATOR

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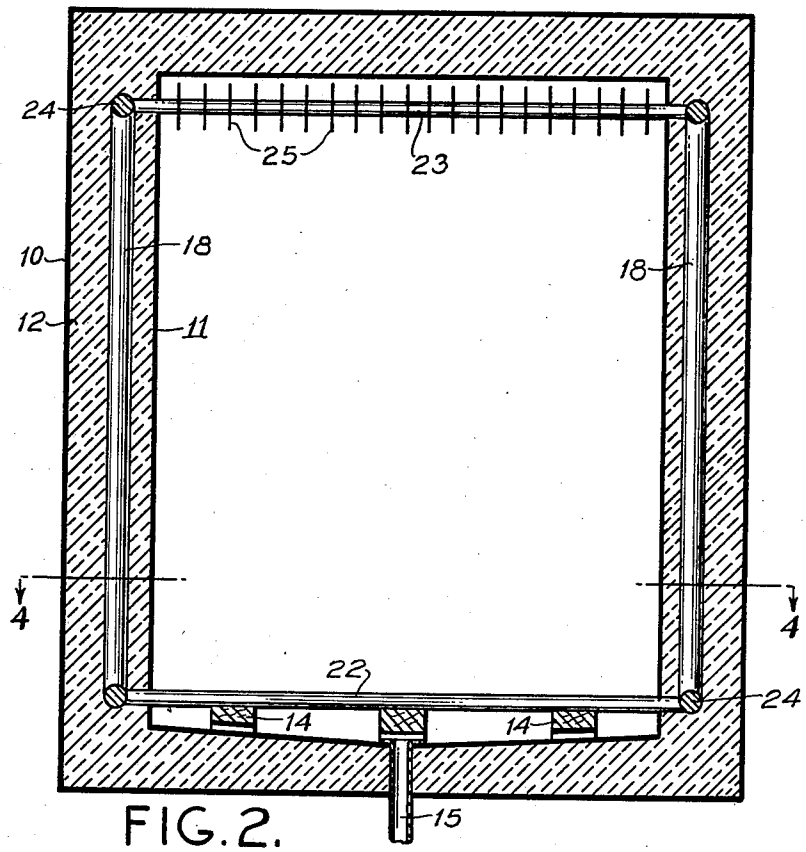


FIG. 2.

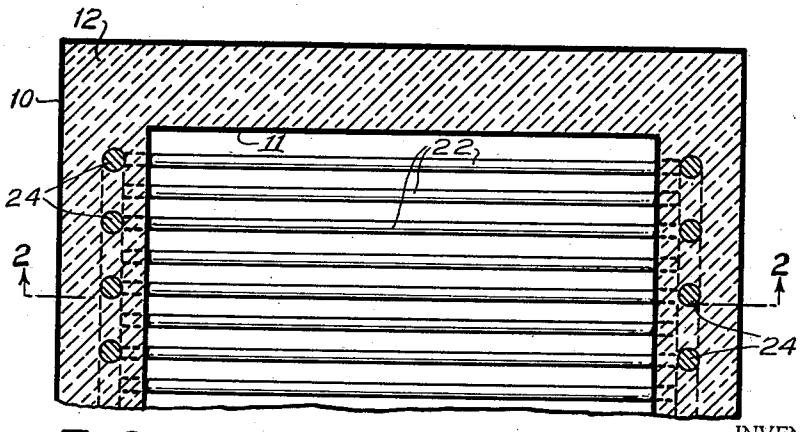


FIG. 4.

INVENTOR.
GOTTHOLD HARRY MEINZER
BY
Paul W. Pritchard
ATTORNEY.

Aug. 10, 1937. G. H. MEINZER 2,089,566

BOTTOM ICING REFRIGERATOR

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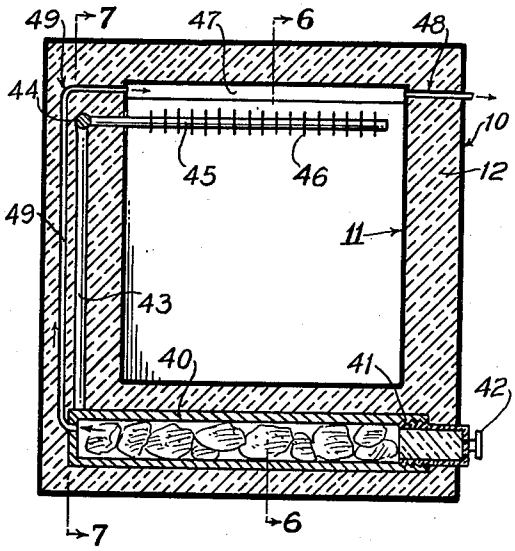


FIG. 5.

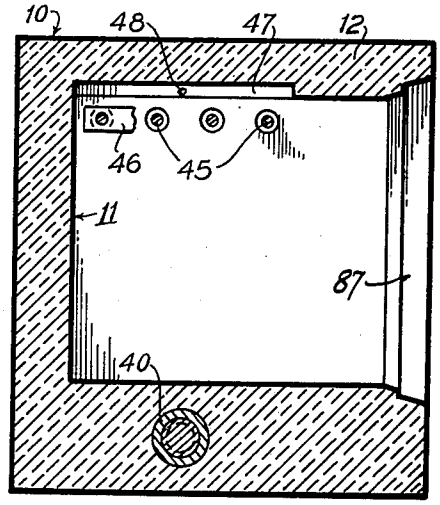


FIG. 6.

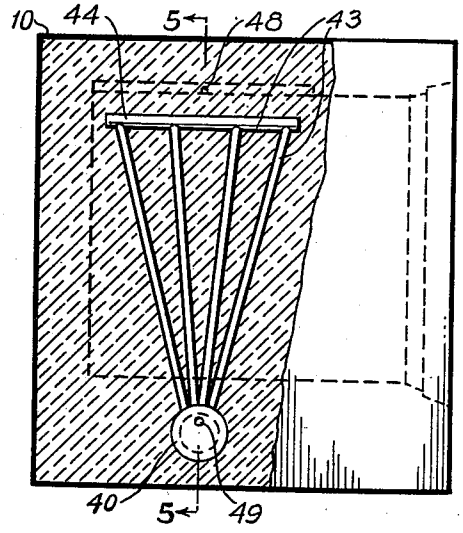


FIG. 7.

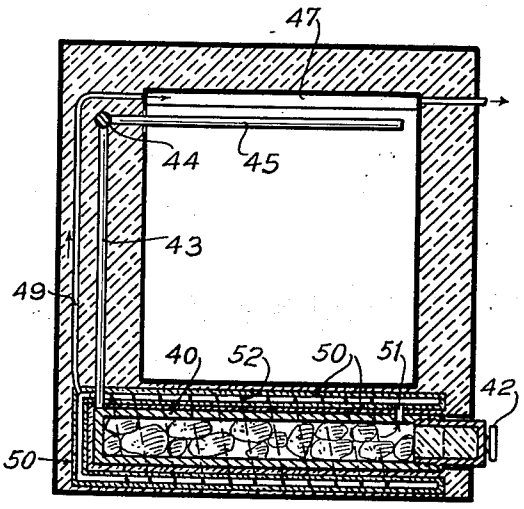


FIG. 8.

INVENTOR.

GOTTHOLD HARRY MEINZER

BY

Paul W. Prutzman

ATTORNEY.

Aug. 10, 1937. G. H. MEINZER 2,089,566

BOTTOM ICING REFRIGERATOR

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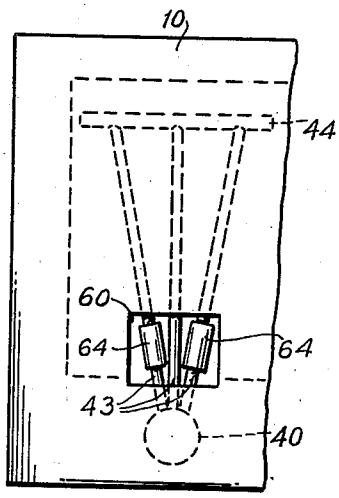


FIG.9.

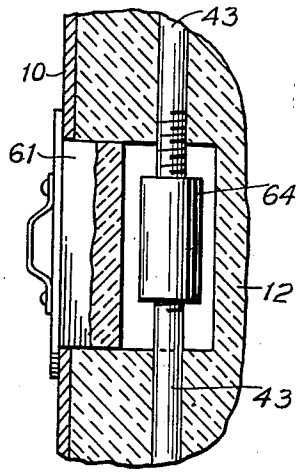


FIG.10

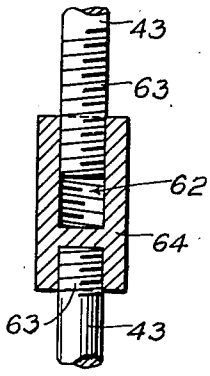


FIG.11.

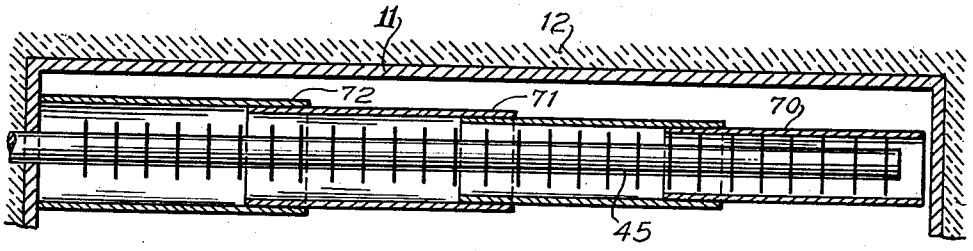


FIG.12.

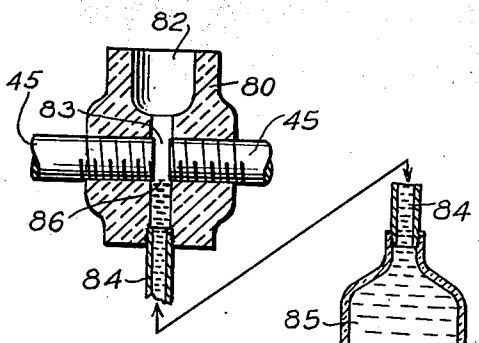
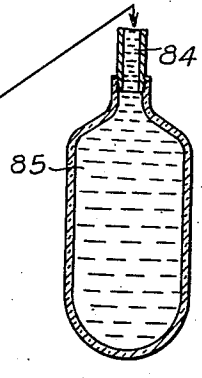


FIG.13.



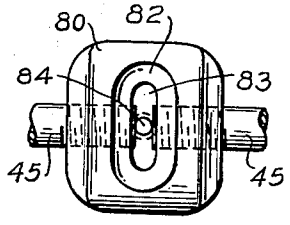


FIG.14.

INVENTOR.

GOTTHOLD HARRY MEINZER

BY

ATTORNEY.

Patented Aug. 10, 1937

2,089,566

UNITED STATES PATENT OFFICE

2,089,566

BOTTOM ICING REFRIGERATOR

Gotthold Harry Meinzer, Glendale, Calif., assignor to California Consumers Corporation, Los Angeles, Calif., a corporation of California

Application July 1, 1935, Serial No. 29,418

10 Claims. (Cl. 62—63)

The primary object of my invention is to provide a refrigerator of the type on which the cooling effect is produced by the melting of a solid such as ice, in which the cooling solid is placed in the bottom of the cooled compartment.

A further object of my invention is to provide a refrigerator of the class described which is adapted to the use of solid bodies other than water ice, such for example as solid carbon dioxide or so-called "dry ice".

It is well known that in the class of refrigerators which are cooled by the melting of ice, the ice is always placed in the top of the refrigerator. The obvious reason for this procedure is that cold air is heavier than that which is warmer and that therefore the cooling effect must be applied at substantially the top of the vessel to be cooled in order to produce the circulation by which the cooling effect is equalized throughout the vessel.

This requirement has been a serious drawback to the use of iced refrigerators, for several reasons. First, and particularly in large units, the ice has to be lifted to a relatively high level and lowered into the ice compartment by a movement which is essentially awkward and difficult. Second, the ice compartment must be separated from the storage compartment of the refrigerator by a heat transmitting partition which is almost of necessity frail and little adapted to support the weight of ice which rests on it. Third, this partition is immediately above the food compartment and any leakage through or around the partition tends to drop into articles stored in this compartment.

For these reasons, as well as others of less importance, the provision of a refrigerator which could be iced below instead of above the food compartment has long been desired, and many attempts have been made to provide such a device in a workable form. It is evident that the thermo-syphon principle is not applicable for the transmission of heat from the top of a vessel to a heat-absorbing agent at the bottom, and the previous attempts to equalize the temperature have been confined, so far as I know, to mechanical devices such as fans for producing air circulation. These devices are fully functional and are desirable for large installations but are hardly applicable to household refrigerators or other small units.

My invention comprises means for withdrawing heat from the upper or uppermost portion of a storage compartment and for transmitting that heat to the cooling medium placed substantially below the storage compartment and, in certain modified forms of the invention, means for controlling the rate at which the heat is transmitted. By the first named means a cooling effect which is initiated at the bottom of the chamber is exercised at any desired location in the upper part of the chamber and, as the air thereby cooled tends to move downwardly in the storage space, the temperature within that space is automatically equalized. By the second named means any desired temperature difference between the heat-absorbing element in the top of the storage space and the cooling medium in the bottom thereof may be maintained, and thus it becomes possible to utilize cooling media such as dry ice which by unrestrained evaporation produce temperatures far below those which can be tolerated in a refrigerator.

The various features of the invention may best be explained with reference to the attached drawings and the following description thereof, in which

Fig. 1 illustrates in cross section and partial elevation, as on the line 1—1 of Fig. 3, a modification of the invention adapted to the use of water ice;

Fig. 2 illustrates in the same manner and as on the line 2—2 of Fig. 4, another modification adapted to the use of water ice;

Fig. 3 is a plan section on the line 3—3 of Fig. 1;

Fig. 4 is a plan section on the line 4—4 of Fig. 2;

Fig. 5 is a cross section through a modification of the invention adapted to the use of solid carbon dioxide, as on the line 5—5 of Fig. 7;

Fig. 6 is a section illustrating the same modification, taken on the line 6—6 of Fig. 5;

Fig. 7 is a section illustrating the same modification, taken on the line 7—7 of Fig. 5;

Fig. 8 is a section similar to Fig. 5 but illustrating a modified manner of insulating the carbon dioxide container;

Figs. 9 to 14, inclusive, are details illustrating preferred means for controlling the flow of heat from the heat-absorbing element to the carbon dioxide container.

Referring first to Figs. 1 and 3, 10 is an outer and 11 an inner casing of metal, enameled metal or other suitable material separated by a relatively thick layer of low temperature insulating material 12, a suitable insulated door of substantially the same materials being provided but not shown. This door forms a portion of one

of the vertical walls of the refrigerator, as is conventional and as indicated at 87 in Fig. 6.

In the lower part of the box thus formed I place a supporting screen 13 on which ice may be placed as required. This screen is formed of stiff and relatively closely woven heavy wires of a heat-conductive metal as for example aluminum or copper and may rest on supports indicated at 14 to permit drainage of melt into a drain pipe 15. It is desirable though not strictly essential to firmly fix the ends of the wires composing the screen in an edging strip 16 of the same metal in such manner that heat conduction to the screen will not be interfered with by films of oxides or other corrosion products. A similar screen 17 is supported in the upper portion of the box by means of standards 18—18 formed of heat-conductive metal, the standards being brought into heat-conductive relation with the edging strips or with the screen itself, as for example by the threaded studs 19 and the nuts 20, or by riveting or merely by soldering. If a pressural contact is made, it may be desirable to prevent corrosion which might reduce the efficiency of the contact by dipping the entire assembly in a molten metal such as tin or zinc and thus sealing all the joints against the intrusion of moisture.

It is also desirable, though again not strictly necessary, to insulate the heat-conductive standards 18—18 against transfer of heat from or to the air within the box, in order to maintain the greatest possible temperature difference between the screen 17 at the top of the box and the screen 13 on which the ice rests. Such insulation is indicated at 21 in Figs. 1 and 2.

When a cooling medium such as ice is rested on the lower screen 13, the metal of the screen is cooled to the temperature of melting ice, or close to 32° F., and the temperature of the upper screen 17 is rapidly reduced by the conduction of heat to and through the metallic rods 18, to and through the edging strips 16 and finally through the lower screen 13 to the ice, which melts without rising in temperature. Whenever the temperature of the upper screen falls below the temperature of the immediately surrounding air, heat is transmitted from the air to the upper screen and through the same course to the ice. By providing sufficient areas in the conductive rods and taking reasonable precautions to see that the joints are fully conductive, the temperature of the upper screen may be maintained within not over 2° F. and in favorable cases as little as 1° F. above that of the lower screen.

The air thus cooled being heavier than the warmer air in the body of the box, convection currents are set up by which heat is constantly transmitted to the upper screen, to be removed by conduction as above described, and in this manner the air in the box may be reduced in temperature at substantially the same rate as it would be reduced by contact with a block of ice placed in the upper part of the box and having no greater superficial area than that of the upper screen. In fact it is possible to effect the cooling by the described means at an increased rate, if the surface of the screen be blackened as by the oxidation of copper, such blackened surfaces absorbing heat more freely than the reflective surface of an ice cake.

The above device is subject to several modifications, certain of which are illustrated in Figs. 2 and 4. Thus, the lower screen or the upper screen or both may be replaced by the parallel bars 22 and 23, these bars, if more numerous than the rods 18, being connected to equalizing bars 24. Again, the rods 18 and the equalizers 24 (if used) may be placed within the insulating layer 12, this being obviously advantageous as keeping the interior vertical walls of the box free from obstruction. Again, the heat-absorbing capacity of the upper bars 23 may be increased by providing them with fins 25 in the well known manner.

A form of the device adapted specifically to the use of very low temperature refrigerants such as solid carbon dioxide (the so-called dry-ice) is illustrated in Figs. 5 to 14 inclusive.

In Figs. 5 to 7, inclusive, 10 and 11 are outer and inner shells respectively and 12 is a thick layer of low temperature insulating material. In some preferred portion of this bed of insulation, illustrated as being the lower portion, I place a gas tight receiver for holding a supply of dioxide, this receiver consisting of a thick walled metallic case 40, closed at one end and provided at the opposite end with a coarse screw thread 41 and a threaded plug 42. The plug should be formed of heat insulating material (e. g., a shell of molded synthetic resin filled with cork) and should extend to the exterior of the outer shell so that it may be removed without opening the door of the refrigerator. The case 40 should be of some heat-conductive metal such as copper.

To the closed end of the case are attached a plurality of risers 43, in the form of solid copper or aluminum rods. All of these risers are joined in a heat-conductive manner to the wall of the case and at their upper ends to an equalizing bar 44 of the same metal. To this bar are similarly attached a plurality of horizontal conductive rods 45 which pass through the inner shell (preferably without contacting with it and extend across the upper part of the space within the inner shell. These rods may be provided with the fins 46 if desired.

The gas evolved by evaporation of the solid dioxide is at a very low temperature and is capable of absorbing considerable heat. This refrigerating value may be recovered by providing a chamber 47, the lower wall of which comprises a portion of the inner shell 11 and is in contact with the air within the refrigerator. This chamber is vented as at 48 and a tube 49 leads from the interior of the receiver 40 into the opposite end of chamber 47. This chamber may be provided with internal baffles to cause the gas to make a circuitous course and to come to substantially the temperature of the air with which the lower wall of the chamber is in contact before it is vented. The vent 48 may desirably be provided with either an outwardly opening check valve or a dessicating trap, not shown, to prevent atmospheric moisture from entering and forming frost in the chamber.

As it is absolutely essential to restrain atmospheric heat from penetrating to receiver 40, I prefer to first pass the evolved gas through the insulating shell indicated at 50 in Fig. 8. The gas evolved in the receiver passes into this shell through a tube 51 and is directed by the helical fin 52 in a circuitous course through the shell, finally passing out through tube 49 to chamber 47 as above described. If this shell is separated from the receiver by a sufficient layer 52 of insulating material, any atmospheric heat which may penetrate the layer of insulation surrounding the shell will be almost totally absorbed in slightly warming the gas, and this heat will therefore be substantially prevented from penetrating to

the wall of the receiver and causing an undesired evaporation of the solid dioxide.

When solid carbon dioxide is placed in the receiver 40 and the plug 42 inserted, carbon dioxide gas is rapidly evolved and passes through tube 49 into chamber 47 and thence to the outer air. By this evaporation of the solid dioxide the case itself and the insulating material immediately surrounding it are rapidly brought to a very low temperature, approximating the boiling point of carbon dioxide or —79° C.

If there were no passage of heat into the rods 45, the entire metallic assembly of case 40, risers 43, bar 44, and rods 45 would soon attain the same temperature and, assuming that leakage of heat into the case is substantially prevented, evaporation of the dioxide would cease because of lack of heat supply.

This, of course, does not take place, as heat is transmitted from the air in the upper portion of the refrigerator to the rods 45 and from them is conducted in the reverse direction through the above named metallic assembly, to be finally absorbed in evaporating further quantities of the dioxide. It will be evident, then, that if we can control the flow of heat from the air within the refrigerator to the carbon dioxide within the case, we can fully control the rate at which refrigeration of the air is effected, and it will further be evident that this control may be effected either at the point where heat is transmitted from the air to the rods 45 or somewhere along the system by which this heat is passed on to the receiver 40.

The lack of relationship between rate of heat transmission and ultimate temperature of refrigeration should be kept clearly in mind. No matter how low the transmission rate, a permanently closed refrigerator will ultimately attain that (usually close) approach to the evaporating temperature of the refrigerant at which the transmission of heat from the internal air to the refrigerant just balances the transmission of heat through the refrigerator wall from external to internal air.

It is therefore theoretically impossible to control the ultimate temperature by any fixed control of the transmission rate, that is, by any control which is not directly responsive to temperature changes within the refrigerator. None the less it is highly desirable to be able to effect a relatively fixed or manual control of the transmission rate in order to bring it into an approximate balance with the heat input to an individual refrigerator under the conditions obtaining in its use and under varying climatic conditions. Such controls avoid too great a heat head between internal air and absorbing rods, which tends to produce an undesirable temporary supercooling, and also avoids excessive hunting of a heat responsive device. In cases where a refrigerator is in constant use and opened at fairly regular intervals, as in large commercial installations, such manual controls may function without temperature responsive devices within safe temperature limits if the transmission rate be sharply reduced prior to periods of idleness.

For exercising a manual control of the transmission rate from rods 45 to receiver 40 I provide means for selectively interrupting the flow of heat through individual risers 43. Thus, as in Figs. 9 and 10, an opening 60 is found through the outer shell 10 at such point as to expose rods 43 at some location where they are close together, an insert plug 61 of insulating material being provided to close this opening. Within this opening one or more of the risers is broken as at 62 and each end threaded as at 63, one of these threads being relatively long. On the long thread is placed an internally threaded connector 64, shown in detail in Fig. 11, the threaded ends of the riser sections being so spaced that this connector may be run down to form a firm contact with the lower section without passing off of the upper thread. If all of the risers are similarly provided, the flow of heat may be interrupted completely or may be regulated by as many steps as there are individual rods. The particular device shown in these figures is intended to be illustrative only as it will be evident that many other means could be used for making and breaking the heat conductivity of the risers, or that such devices might alternatively be applied to the rods 45.

The transmission rate may also be manually controlled by regulating the flow of heat from the internal air to the heat-absorbing means such as the fins 46 and/or rods 45. For illustration, the sleeves 70—71—72 of Fig. 12 may be arranged to telescope so as to cover only a short section of the rod or to be drawn out as shown in the figure to cover a part or all of the rod and fins, thereby stopping the flow of air over the rods, which is normally produced by convection currents. Such devices, again, are subject to a wide variation in form.

The necessity for manual control may be avoided and the minimum temperature in the refrigerator automatically controlled by providing temperature responsive means for breaking the continuity of the heat-conductive system. A simple device for this purpose, which might have many mechanical variants, is illustrated in Figs. 12 and 13.

In these figures, one or more of the rods 45 is interrupted by the interposition of a nonconductive block 80 of some rigid material such as a molded synthetic resin. The ends of the interrupted rods are firmly fixed in this block as at 81—81 and one rod section (ordinarily that within the refrigerator) is given a free support to prevent the destruction of the block by expansion and contraction due to temperature changes.

In the center of the block is formed a well 82 into which the rod ends project, leaving a relatively narrow space 83. The well communicates through this space and a connecting tube 84 with a mercury bottle 85 placed in any part of the refrigerator in which it is desired to control the temperature. The bottle and the channel above described are filled with mercury and the quantity so adjusted that when the desired minimum temperature is reached the upper end of the mercury column will be at or slightly above the level indicated at 86, the heat-conductive connection between the rod ends being then almost or quite broken. As the temperature rises above this desired minimum, the resultant expansion of the mercury causes it to fill the space 83 and restore the heat-conduction connection. The volume of mercury in the bottle should bear such relation to the capacity of space 83 that the space will be completely filled and the heat conductivity fully restored in response to a temperature rise of only a few degrees. On account of the relatively low heat conductivity of mercury it is desirable that the space between the rod ends should be narrow.

I claim as my invention:

1. A refrigerator comprising: a receptacle in-

sulated to exclude atmospheric heat; a metallic, heat-conductive support for a solid refrigerant located at substantially the bottom of said receptacle; a wholly metallic heat-absorbing element substantially horizontally arranged adjacent the upper horizontal wall of said receptacle and within said receptacle; a heat-conductive metallic element connecting said heat-absorbing element with said supporting element; an opening in said receptacle and a closure therefor, said opening arranged to permit the introduction of said refrigerant onto said support by a substantially horizontal movement.

2. A refrigerator comprising: a receptacle insulated to exclude atmospheric heat; a metallic, fully exposed heat-conductive support for a solid refrigerant located in the lower portion of said receptacle; a wholly metallic and fully exposed heat-absorbing element located in the upper portion of said receptacle and in contact with the air therein, and a heat-conductive metallic element connecting said heat-absorbing element with said supporting element, said heat-conductive connecting element being insulated throughout substantially its entire length to restrain the flow of heat from the air within said receptacle into said connecting element.

3. A refrigerator comprising: a receptacle insulated to exclude atmospheric heat; a metallic, heat-conductive support for a solid refrigerant located in the lower portion of said receptacle; a heat-absorbing element located in the upper portion of said receptacle and in contact with the air therein; a heat-conductive metallic element connecting said heat-absorbing element with said supporting element, and means for interrupting the heat conductivity of said heat-conductive connecting element.

4. A refrigerator comprising: a receptacle insulated to exclude atmospheric heat; a heat-conductive support for a solid refrigerant located in the lower portion of said receptacle, said support being in the form of a metallic grid and having a header bar; a heat-absorbing element located in the upper portion of said receptacle and in contact with the air therein, and a heat-conductive element connecting said heat-absorbing member with said header bar.

5. A refrigerator comprising: a receptacle insulated to exclude atmospheric heat; a metallic, heat-conductive support for a solid refrigerant located in the lower portion of said receptacle; a heat-absorbing element located in the upper portion of said receptacle and in contact with the air therein, said element being in the form of a metallic grid and having a header bar, and a heat-conductive element connecting said support with said header bar.

6. A refrigerator comprising: a receptacle insulated to exclude atmospheric heat; a metallic, heat-conductive support for a solid refrigerant located in the lower portion of said receptacle; a heat-absorbing element located in the upper portion of said receptacle and in contact with the air therein, and a plurality of heat-conductive metallic elements connecting said heat-absorbing element with said supporting element, at least one of the individual connecting elements being provided with means for interrupting its heat conductivity.

7. A refrigerator comprising: a receptacle insulated to exclude atmospheric heat; a metallic, heat-conductive support for a solid refrigerant located in the lower portion of said receptacle; a heat-absorbing element composed substantially entirely of a solid metal and located in the upper portion of said receptacle, said element having its metallic surfaces freely exposed to contact with air currents within said receptacle over substantially its entire area, and heat-conductive means connecting said element with said support.

8. A refrigerator comprising: a receptacle insulated to exclude atmospheric heat; a substantially closed metallic vessel adapted to retain solid carbon dioxide, the wall of said vessel being spaced and insulated from the interior of said receptacle; a heat-absorbing element composed substantially entirely of a solid metal and substantially horizontally arranged within said receptacle and adjacent the upper horizontal wall thereof, the metallic surfaces of said element being freely exposed to contact with the air in said receptacle, and a metallic element connecting said heat-absorbing element with the wall of said vessel and adapted to transmit heat from said heat-absorbing element to said carbon dioxide.

9. A device substantially as and for the purpose set forth in claim 8, including a chamber horizontally arranged above said heat-absorbing element and in heat-conductive relation with the air within said chamber, and means for cooling the lower wall of said chamber by the passage through said chamber of gas evolved from said solid carbon dioxide.

10. A device substantially as and for the purpose set forth in claim 8, including means for fixing a minimum temperature within said receptacle, said means comprising heat-responsive means submerged in the air within said receptacle and insulated from said heat-absorbing element, and means cooperating with said heat-responsive means for interrupting and reestablishing the heat conductivity of said connecting element.

GOTTHOLD HARRY MEINZER.