

Sept. 6, 1938.

C. H. ANDROS

2,129,255

REFRIGERATOR

Filed Oct. 31, 1936

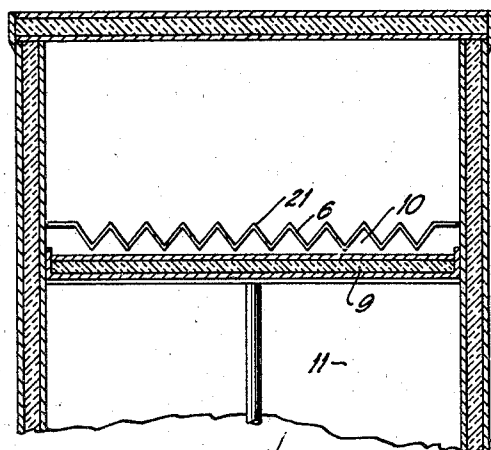


FIG. 1

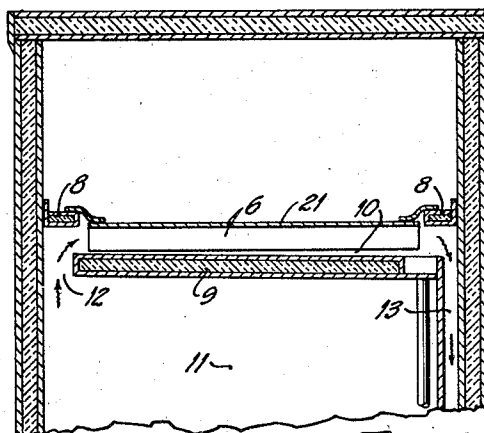


FIG. 2

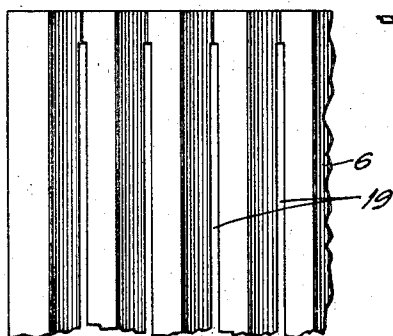


FIG. 4

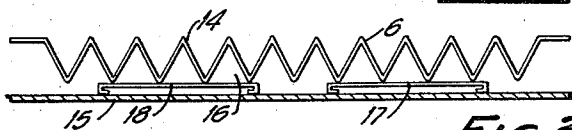


FIG. 3

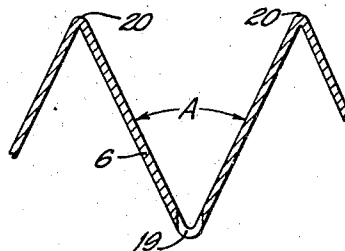


FIG. 6



FIG. 7

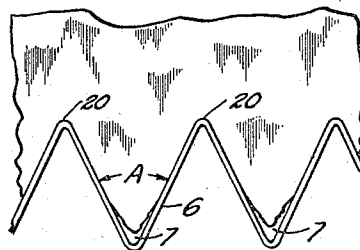


FIG. 5

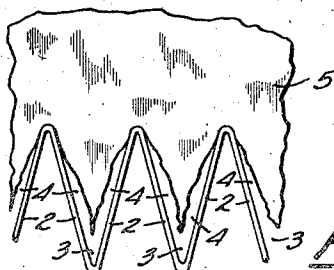


FIG. 8

INVENTOR
CHARLES H. ANDROS

By R. V. Crabtree
ATTORNEY

UNITED STATES PATENT OFFICE

2,129,255

REFRIGERATOR

Charles H. Andros, Nassau, N. Y., assignor to
Harder Refrigerator Corporation, Cobleskill,
N. Y., a corporation of New York

Application October 31, 1936, Serial No. 108,660

6 Claims. (Cl. 62-46)

My invention relates to refrigerators and particularly to a new and improved type of air duct through which the air to be cooled is circulated.

In many modern types of ice refrigerators a block of ice is supported on a rack beneath which is disposed a partition or drip pan which cooperates with the rack or the bottom of the ice block, or both, to form a passage or duct through which the air to be refrigerated is circulated.

There are many varieties of ice racks. Some comprise spaced bars upon which the ice is supported so that the portions of the ice between the bars are exposed directly to the underflowing air. Others consist of more or less imperforate metal sheets forming a support for the ice, and the air to be refrigerated is cooled by flowing in contact with the underside of the support. In some types of ice support comprising spaced bars, extended, heat-conducting surfaces depend downwardly from the bars into the path of movement of the air to be refrigerated whereby some increased efficiency is attained. In other types of ice support comprising an imperforate plate, extended heat-conducting fins or surfaces depend downwardly therefrom into the path of air flow.

In cases where the ice support is of comparatively thin sheet metal, it has frequently been corrugated in order to stiffen it against flexure under the load of the ice thereon, and it has even been proposed, in a broad sense, to corrugate it in order to increase the area thereof exposed to the action of the ice.

The principal object of my invention is to provide, in an ice refrigerator, an air duct of an improved type through which the air to be refrigerated is circulated and which, by reason of the particular type of construction hereinafter described, functions very much more efficiently to effect a heat transfer from the air to the ice than do the present type of ducts.

With this object in view, my invention includes the novel elements and combinations of elements described below and illustrated in the accompanying drawing in which—

Fig. 1 is a fragmentary cross sectional elevation of a refrigerator;

Fig. 2 is a fragmentary cross sectional elevation of the refrigerator taken in a plane at right angles to the section shown in Fig. 1;

Fig. 3 is a cross section of one type of duct;

Fig. 4 is a fragmentary plan view of the ice support;

Fig. 5 is a fragmentary cross section of the ice support with ice thereon;

Fig. 6 is an enlarged fragmentary section of my grid; and

Figs. 7 and 8 are fragmentary cross sections of extreme types of grids.

I find that, where warm air to be refrigerated is circulated in direct contact with a body of ice, heat transfer from the air to the ice takes place much less rapidly than is the case where the air is circulated in contact with one side or surface of a thin, metallic, heat-conductor having its other side or surface in contact with the ice substantially throughout. I find further that in the latter case heat transfer takes place most rapidly where the ice is held in intimate contact with the thin metal heat conductor by pressure such as may be due to the weight of the ice resting on the conductor.

It is desirable in all cases so to arrange the structure of the refrigerator that the heat transfer from the air to the ice, or at least the major portion of the transfer, takes place substantially at the bottom of the body of ice. Since the specific gravity of air decreases with the temperature, the molecules of a body of air moving through a horizontal or substantially horizontal duct naturally arrange themselves so that the warmest air flows along the top of the duct and the coldest air along the bottom. Hence, to effect a rapid absorption of heat from the flowing air stream it is at least theoretically desirable to provide a duct having a refrigerated top or ceiling with as large a surface area as possible exposed to the flowing air stream so that a maximum volume of the moving air may flow directly in contact therewith.

Where the metallic heat conductor upon which the ice rests and which forms the top of the air duct is a plane or substantially plane surface, or if provided with shallow stiffening corrugations as shown for example at 1 in Fig. 7, the ice, by its weight, is held substantially in contact throughout the entire upper surface of the heat conductor, but the surface area of the lower side of the heat conductor with which the air flows in contact is not substantially increased over the horizontally projected area of the bottom of the body of ice.

On the other hand, where the ice support is deeply and sharply corrugated, as in U. S. Letters Patent No. 2,061,155 granted to M. Hokanson on November 17, 1936, as shown at 2 in Fig. 8, the area of the underneath side of the ice support and with which the air flows in contact is very substantially increased over the horizontally projected area of the bottom of the ice.

In these cases, however, the weight of the ice is insufficient to maintain the V-shaped valleys 3 filled or substantially filled with ice. The ice melts away from the sides of the valleys leaving air spaces, such as shown at 4, between the ice 5 and the heat conductor. Air is a poor conductor of heat, and in such a case, due to the presence of the air pockets 4 between the surface of the ice and the upper surface of the heat conductor, heat transfer from the air flowing in contact with the under surface of the conductor takes place comparatively slowly and hence the arrangement is not much more efficient than that shown in Fig. 7.

Depending upon the temperature and volume of air to be refrigerated, it is possible to design an ice support having a structural shape intermediate the shapes shown in Figs. 7 and 8 and such, for example, as is shown at 6 in Figs. 1, 2, 4, 5 and 6 wherein the upper surface of the conductor will always be substantially in contact throughout its entirety with the bottom of the ice and yet such that the under surface of the conductor in contact with the flowing air will be very substantially greater than the horizontally projected area of the ice.

The most efficient depth of valley and the most efficient valley angle A will depend, of course, on the type of refrigerator, the "load" or volume of warm air to be refrigerated, whether the refrigerant compartment is maintained substantially full of ice or whether it is only re-iced when the previous charge has practically entirely melted, and the heat conducting properties of the material used in the conductor.

In any case the proper proportions can be readily determined experimentally, and I prefer so to proportion the grid that the valleys, under average normal operating conditions of heat load and ice supply, are substantially solidly filled with ice except in the extreme bottom portions 7, as shown in Fig. 5.

The condition of the bottom of the ice and whether large air pockets, such as shown at 4, exist between the ice and the grid can be readily ascertained by removing the ice from the refrigerator and turning it upside down. If desirable, the grid may also be removed and laid over the inverted ice in order to observe how they fit together.

In household refrigerators of the types disclosed in U. S. Letters Patent Nos. 2,062,139 and 2,062,140 of Harry L. Merrill, grids of galvanized sheet iron having valley angles A between 40° and 60°, and preferably between 45° and 55°, with valley depths of from 1¾" to 2½", have been very successfully used. In such grids the surface area thereof exposed to the air to be cooled is approximately from two to three times as great as the horizontally projected area of the ice bottom.

It is understood, of course, that the ice rack forms only the upper element or ceiling of my air duct and since, as pointed out above, the flow of the warmest air takes place along the ceiling of the duct it will be apparent that in my arrangement a very substantially greater volume of this air may flow directly in contact with the refrigerated conductor than is the case where the ice rests upon bars or upon a substantially plane surface. In addition to increasing the efficiency of the refrigerator, the very deep corrugations in the grid prevent the ice from turning in the refrigerant compartment after it has once melted down therein.

In Figs. 1 and 2 I have shown a grid 21 supported on ledges 8 at the opposite sides or ends. Below the grid 21 but slightly spaced from the bottom of the valleys is a partition 9 which cooperates with the grid to form therebetween the air duct 10. In the type of refrigerator shown in Fig. 2, the warm air from the storage compartment 11 flows upwardly in the direction of the arrows shown at 12 through the air duct 10 where it is cooled and condensed to flow downwardly through the duct 13 and discharge into the lower part of the storage compartment.

In Fig. 3 I have shown a grid 14 which, instead of being supported on ledges at the sides of the refrigerator compartment, rests on the partition 15 and cooperates therewith to form an air duct 16 therebetween. In order to space the bottom of the grid slightly from the top of the partition, supporting elements 17 and 18 are soldered or otherwise secured thereto.

The bottoms of the valleys may be closed, but narrow openings, such as shown at 19 in Figs. 4 and 6, are preferably provided therein for drainage purposes.

I consider it quite important that the tops of the ridges between the valleys be comparatively sharp, as shown in Figs. 1 to 6, so that initially, at least, the weight of the ice is concentrated thereon and quick penetration of these ridges into the bottom of the ice will effect a quick settlement and filling of the valleys. Moreover, since the warmest air in the duct flows just beneath these ridges, fast meltage along the ridge lines maintains the valleys substantially solidly filled with ice.

From the foregoing it will be apparent that I have provided an ice duct having a very large surface area directly in contact with the refrigerant and hence, since the partition or drip pan below the grid and forming the bottom of the duct is maintained in closely spaced relation to the grid, practically all of the air flowing through the duct will flow in contact with the refrigerated surfaces of the metal grid and be rapidly cooled thereby, and to a much lower temperature than is possible with the ordinary types of air duct. While it is desirable to maintain the bottoms of the valleys out of contact with the surface of the partition or drip pan, as shown in the drawing, I consider the close spacing of the grid and partition a very important feature of my invention. Where the bottom of the grid is positioned substantially above the partition, the cooling efficiency is very greatly reduced because a great proportion of the volume of air flowing through the duct does not directly contact the cold surface of the grid.

What I claim is:

1. In an ice refrigerator, the combination with an ice support comprising a metal plate formed with a plurality of alternating sharp-crested V-shaped ridges and valleys therein, the angles formed by the sides of the valleys being between about 40° and about 90°, and the depth of said valleys being so proportioned in relation to the temperature and rate of circulation of said air that said valleys are maintained substantially solidly filled with ice throughout, of means below and in closely spaced relation to the bottom of said support and cooperating therewith to form a shallow air duct therebetween; whereby to confine the major portion of the air flowing there-through in close proximity to the sides of said ice-filled valleys.

2. In an ice refrigerator, a cabinet having a

partition therein subdividing the interior of said cabinet into an ice compartment above and a storage compartment below, a grid positioned above said partition and comprising a metal plate formed with a plurality of alternating, sharp crested, V-shaped ridges and valleys therein, and means for supporting said ice grid on said partition with the bottoms of said valleys in closely spaced relation thereto whereby to form therebetween a shallow air passage in which the air flowing therethrough will be confined in close proximity to the sides of said valleys.

3. In an ice refrigerator of the type in which air to be cooled is circulated in heat-transfer relation to the bottom of a body of ice, the combination of means upon which the bottom of the ice rests comprising a metal plate formed with a plurality of spaced, sharp-crested ridges therein with V-shaped valleys between, whereby heat transfer from said means to said ice will, at least initially, be concentrated along said ridges and thereby cause said ridges, due to their sharp crests, to penetrate rapidly into the bottom of said body of ice and those portions of the bottom of said ice body between said ridges to settle into said valleys and lie in contact substantially throughout the sides of said valleys, and means cooperating with and spaced from the bottom of said first mentioned means to form therebetween a shallow air passage, whereby closely to confine the flow of air therethrough to the bottom of the ice supporting means and in high heat-transfer relation to the bottom of said ice.

4. In an ice refrigerator, the combination with an ice support comprising a metal plate formed with a plurality of comparatively deep, valleys

therein with sharp-crested ridges between said valleys upon which said ice initially rests, of means below said ice support and cooperating therewith to form a shallow air duct through which a substantial portion of the air flowing therein will pass in high-heat-transfer relation to the sides of said valleys; the ends of said valleys at the air inlet end of said duct being open whereby air may enter said valleys.

5. In an ice refrigerator, the combination with an ice support comprising a metal plate formed with a plurality of comparatively deep, valleys therein with sharp-crested ridges between said valleys upon which said ice initially rests, of means below said ice support and cooperating therewith to form a shallow air duct through which a substantial portion of the air flowing therein will pass in high-heat-transfer relation to the sides of said valleys; said valleys being of substantially uniform depth throughout and the ends thereof at the air inlet end of said duct being open whereby air may enter said valleys.

6. In an ice refrigerator, an air duct extending in a generally horizontal direction through which air to be cooled is circulated and comprising a metal top element forming a support for the ice and having formed therein a plurality of sharp-crested ridges with V-shaped valleys between of substantially uniform depth throughout, and a bottom element closely spaced to the bottoms of said valleys at least at one end thereof, whereby the major portion of the air flowing through that zone of said duct where said elements are closely spaced will flow in high-heat-transfer relation to the sides of said valleys.

CHARLES H. ANDROS.