Sept. 4, 1945. P. R. M. M. KÖHLER 2,384,313

EVAPORATOR FOR ABSORPTION REFRIGERATING APPARATUS

Filed June 17, 1942 2 Sheets-Sheet 1

Fig. 1.

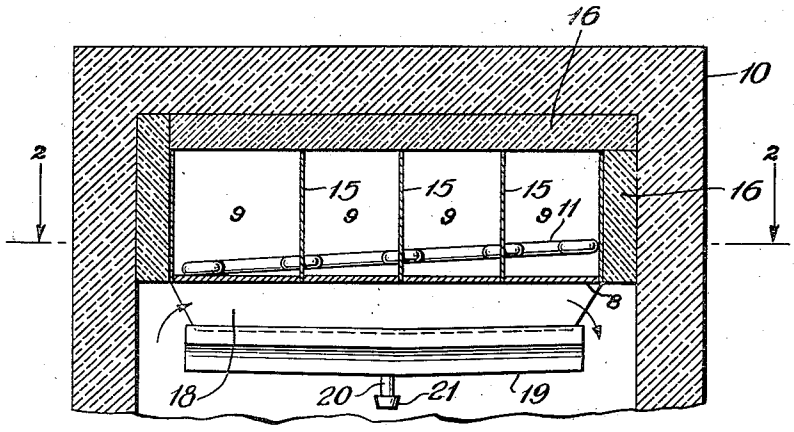

Fig. 2.

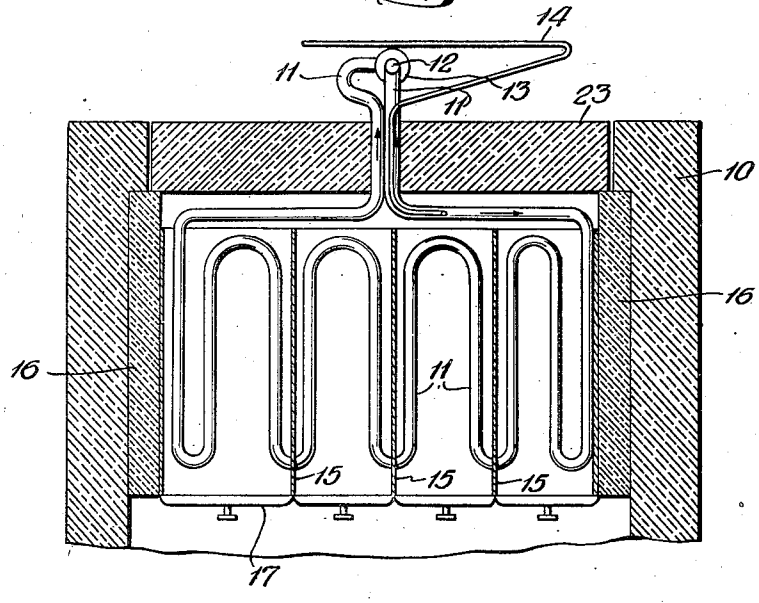

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Fig. 3.

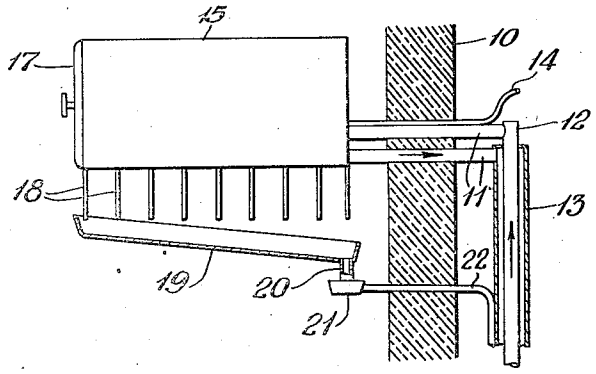
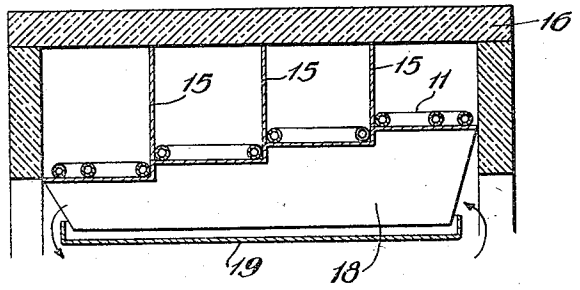


Fig. 4.



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UNITED STATES PATENT OFFICE

2,384,313

EVAPORATOR FOR ABSORPTION REFRIGERATING APPARATUS

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Application June 17, 1942, Serial No. 447,355
In Sweden June 17, 1941

11 Claims. (Cl. 62—103)

My invention relates to an evaporator for absorption refrigerating apparatus built into refrigerator cabinets and working with an inert gas, and has for its object to utilize the difference of temperature in the evaporator in a more rational manner than has been possible hitherto in refrigerating apparatus working with an inert gas.

In compression refrigerating plants it has previously been proposed to divide the evaporator of the apparatus into a plurality of cooling chambers. It has also been proposed to give, in the case of apparatus with an inert gas, the evaporator the shape of a coil spread out chiefly in a horizontal plane and to provide a low-temperature cooler between the horizontal evaporator primarily intended for cabinet-cooling and the heat-insulated roof of the refrigerator cabinet. The evaporator parts working at higher temperatures are thus, in the previously known plant, located in a lower plane than the low-temperature part of the evaporator. This arrangement, however, causes various difficulties, especially as regards the circulation of the air in the refrigerator cabinet and the draining of the atmospheric moisture deposited on the evaporator. The invention eliminates these drawbacks, and is characterized chiefly in that the evaporator is divided into two or more cooling compartments located side by side and immediately beneath the ceiling of the cooling space, suitably occupying in their entirety the total width of the cooling space, of which compartments each encloses a part of the evaporator of the apparatus suitably formed as a coil, being thus kept at a temperature which corresponds to the temperature of the coil part in question and which is different in the case of two or more compartments.

The invention will in the following be more fully described with reference to the embodiments shown in the accompanying drawings. In this connection further characteristics of the invention will be set forth.

Figs. 1–3 show diagrammatically an evaporator according to the invention. Fig. 1 is a front view, Fig. 2 a plan view taken at line 2—2 of Fig. 1, and Fig. 3 a side view of the arrangement. Fig. 4 shows a further example of the application of the invention. In the figures, 10 designates the upper part of a refrigerator cabinet between the inner and outer liners of which a heat-insulation of a suitable kind is built in. For the sake of simplicity the liners of the refrigerator cabinet are not, however, shown but only the heat-insulating layer. In the upper part of the cabinet there is arranged an evaporator 11 belonging to an absorption refrigerating apparatus not shown in the figures and working with an inert gas. This apparatus may be of any generally known kind. The evaporator 11 is in the shape of a plane tubular coil the form of which appears from Fig. 2. The tubular coil is arranged in a plane sloping in the figure from the right to the left in order to prevent the path of flow through the tubular coil being blocked, if the cabinet should be set up in the wrong way. As appears from Fig. 3, the evaporator coil is connected to the remaining refrigerating apparatus not shown in the figure by way of a gas heat exchanger of a kind known per se the inner tube of which is designated by 12 and the jacket of which is designated by 13. Further, 14 designates the supply conduit for liquid refrigerant connected to the condenser not shown in the figure.

As appears from Fig. 2, the evaporator coil is bent into repeated S-bends. The bends located nearest to the opening of the cabinet may suitably have a relatively small radius of curvature, whereas the bends located at the back of the cabinet may suitably have such a large radius of curvature that a sufficient width ensues between two successive straight tube lengths. By arranging partitions 15 between two or more straight tube lengths of this kind it is possible to obtain two or more separated cooling compartments or chambers 9, amounting in the embodiment shown to four. These are, as appears from Fig. 2, of various width. Also the length of the part of the evaporator coil located within each chamber 9 of this kind varies, being largest in the compartment situated at the extreme left and smallest in the two central compartments. For the purpose of facilitating the assembly but also from a thermic point of view it is advantageous to provide plates of heat-insulating material between the outer walls of the generator and the insulation of the refrigerator cabinet 10, said plates being designated by 16 in the figures. The compartments 9 may suitably, as appears from Figs. 2 and 3, be provided with doors 17.

For making possible the cooling also of the cabinet air the undersides 8 of the chambers are provided with a plurality of cooling fins 18 directed downwards and swept over by the air circulating through the cabinet. Both by suitably dimensioning the fins and by suitably choosing the heat-conducting connection between said fins and the source of cold proper it is possible to

cause these fins 18 always to keep a temperature above 0° C., thus preventing the formation of frost. This result may be obtained, even if the evaporator coil or parts thereof work at a temperature far below 0° C., namely by suitably choosing the size and qualities of the heat transfer surfaces. It is possible to arrange the coil 11, the size of the heat transfer compartments 9 and the surface of the underside 8 of the compartments in such manner that the temperature of the fins 18 attached to said bottom 8 is maintained constant in spite of the different temperatures of different coil parts. In the embodiment shown it is, however, assumed that the apparatus works with co-current flow of the inert gas and the refrigerant condensate, that the chamber at the extreme right in the figure has the lowest temperature and that the heat transfer from the coil part located at the extreme right to the cooling sheets 18 is such that the right hand ends of these cooling sheets or fins are maintained at a lower temperature than at their left hand end as viewed in Figs. 1 and 2. Such a difference of temperature has, as will be described in the following, special advantages in many cases.

On the cooling fins 18 water is generally precipitated from the air of the refrigerating cabinet, said water, on account of the temperature above 0° C., forming drops along the lower edge of the fins. For receiving condensed water a drop catcher 19 is provided, as shown in Figs. 1–3. This drop catcher, however, also fulfills other functions. It serves, in fact, in a certain measure as a guide surface or baffle for the air circulating in the cabinet, the direction of the current being indicated in Fig. 1 by arrows. As the air flow, on a considerable portion of its path, comes into contact with the cooling fins 18, the cooling effect will be very high in spite of the relatively high temperature at which the cooling fins are kept. The drying-up of the air will for this reason be substantially less than in refrigerator cabinets in which the air comes into contact with cooling surfaces of low temperature, e. g. —5 to —10° C. The air in the vicinity of the part of the cooling fins 18 located on the right in the figure will cause such an increase of density that the mass of air will flow downwards along the wall of the refrigerator cabinet, at the same time producing a sucking action on the mass of air resting between the drop catcher 19 and the bottom plates of the chambers. A circulation in the direction indicated by the arrows will thus ensue and this circulation will, owing to the cooperation of the cooling fins 18 and the drop catcher 19 acting as a guide surface, be extremely regular, the vertical motion being considerably less than in previously known devices in refrigerator cabinets.

The drop catcher 19 is, in the embodiment shown, arranged with a slight inclination backwards and provided with a short draining tube 20 through which condensed water is, by way of a container 21 and a conduit 22, removed from the cabinet. However, drop catchers of a generally known kind, viz. without draining conduits, may also be used in the arrangement according to the invention. The assembly of the evaporator with the appertaining drop catcher will in this case be extremely simple, as the so-called window insulation 23 need only be broken through at one spot, namely for introducing the conduits into the coil consisting of a number of turns located side by side. In the assembly, these turns may, if desired, be further compressed, it thus being possible to decrease the width of the window. After insertion of the evaporator into the cabinet the insulation 16 may be put in place from the front of the cabinet. The front edge of the drop catcher shown is carried by a suspension device of any kind not shown in the figure, e. g. attached to the lower edge of the fins 18. The side of the drop catcher facing the back of the cabinet may rest against the container 21, e. g. by bearing on a foot attached to the tubular piece 20. The drop catcher should suitably be removably arranged.

Fig. 4 shows diagrammatically a further example of the application of the invention. The insulation of the refrigerator cabinet is not shown in this figure, but only the extra insulation 16 arranged nearest the generator. The evaporator coil 11 is, in this embodiment, arranged with a gradual inclination from the right to the left in such a manner that the bottom plates of the chambers bearing against the respective tubular members will occupy different heights, as shown in the figure. The upper edges of the cooling fins 18 are adjusted to the existing difference of height of the bottom plates of the different chambers, the lower edges of the fins, on the contrary, being situated substantially in a horizontal plane. While the evaporator according to Figs. 1–3 is adapted to work on the co-current principle, the evaporator according to Fig. 4 is especially suited to counter-current flow of refrigerant and gas. In the evaporator according to Fig. 2 the gas washed in the absorber will, together with liquid refrigerant, enter through the inner jacket 12 of the heat exchanger into the part of the evaporator coil located on the right. In Fig. 4, on the other hand, the connection conduit for liquid refrigerant is supposed to enter into the part of the evaporator coil located on the right in the figure, whereas the connection conduit for the gas coming from the absorber and poor in refrigerant is assumed to be connected to the evaporator part located on the left in the figure. Under these conditions the chamber located at the extreme left will assume the lowest temperature, those parts of the fins 18 which are arranged in direct contact with this, the coldest part of the evaporator being at the same time given a corresponding low temperature. This part of the nest of cooling fins 18 is at the same time the shortest as seen in the vertical direction, which further contributes to give this part of the nest of fins the lowest temperature. In conformity to what has been described in connection with Figs. 1–3 this will give rise to a regulated flow of air through the nest of fins and along the walls of the refrigerator cabinet in the direction indicated by the arrows.

It will be obvious to those skilled in the art that various other changes may be made in the construction and arrangement without departing from the spirit of the invention and therefore the invention is not limited to what is shown in the drawings and described in the specification but only as indicated in the following claims.

What I claim is:

1. A refrigerator having a thermally insulated storage space, an absorption refrigeration system including an evaporator in which refrigerant fluid and auxiliary agent flow in the presence of each other, partitions forming a plurality of separate heat conducting compartments immediately beneath the ceiling of said storage space, said compartments having openings at the front and

arranged in contiguous side by side relationship from one lateral side to the opposite lateral side of said storage space, closure means for the compartment openings, said evaporator having a plurality of sections with successive sections arranged in adjacent compartments to effect cooling of said compartments, said refrigerant fluid evaporating in the auxiliary agent at progressively increasing temperatures in the adjacent compartments from one lateral side to the opposite lateral side of the storage space.

2. A refrigerator as set forth in claim 1 including means for thermally insulating said compartments from the walls of said storage space.

3. A refrigerator as set forth in claim 1 including structure thermally associated with said evaporator sections to effect cooling of air in said storage space, said structure being located beneath the bottom of said compartments and including elements providing a relatively extensive heat transfer surface and arranged to cause circulation of air from one lateral side to the opposite lateral side of said storage space in a substantially horizontal direction just beneath said compartments.

4. A refrigerator as set forth in claim 1 including structure thermally associated with said evaporator sections to effect cooling of air in said storage space, said structure being located beneath the bottom of said compartments and including elements providing a relatively extensive heat transfer surface and arranged to cause circulation of air from one lateral side to the opposite lateral side of said storage space in a substantially horizontal direction just beneath said compartments, the thermal association of said elements with said evaporator sections being such that the surface portions of all of the elements beneath any one of the compartments are substantially at the same temperature.

5. A refrigerator as set forth in claim 1 including structure thermally associated with said evaporator sections to effect cooling of air in said storage space, said structure being located beneath the bottom of said compartments and including elements providing a relatively extensive heat transfer surface and arranged to cause circulation of air from one lateral side to the opposite lateral side of said storage space in a substantially horizontal direction just beneath said compartments, the thermal association of said elements with said evaporator sections being such that the portions of said elements associated with said one section are at a lower temperature than the portions thereof associated with another of said sections at a higher temperature.

6. A refrigerator having a thermally insulated storage space, an absorption refrigeration system including an evaporator providing a path of flow for refrigerant which evaporates in the presence of an auxiliary agent, partitions forming a plurality of heat conducting compartments in contiguous side by side relation immediately beneath the ceiling of said storage space and open at the front, the bottom of said compartments forming a sub-ceiling for said storage space from one lateral side to the opposite lateral side thereof, said evaporator having several sections in which one section effects cooling of one of said compartments and another section effects cooling of another of said compartments, closure means for the openings of said compartments, said refrigerant evaporating in the auxiliary agent at a low temperature in one of said sections and at a higher temperature in another of said sections, and structure below the compartments and cooperating therewith to provide a relatively extensive heat transfer surface to effect cooling of air in said storage space.

7. In a refrigerator having a thermally insulated storage space, an absorption refrigeration system including an evaporator providing a path of flow for refrigerant which evaporates in the presence of an auxiliary agent, partitions forming a plurality of heat conducting compartments in contiguous side by side relation immediately beneath the ceiling of said storage space, the bottom of said compartments forming a subceiling for said storage space from one lateral side to the opposite lateral side thereof, said evaporator having several sections of which one section effects cooling of one of said compartments and another section effects cooling of another of said compartments, said refrigerant evaporating in the auxiliary agent at a low temperature in one of said sections and at a higher temperature in another of said sections, and structure associated with the bottom of said compartments providing a relatively extensive heat transfer surface to effect cooling of air in said storage space, said structure being so constructed and arranged that air in said storage space passes from one lateral side to the opposite lateral side thereof beneath said compartments and is cooled to one temperature at said one side and to a lower temperature at said other side.

8. A refrigerator as set forth in claim 7 in which said structure includes a baffle forming a path of flow for air beneath said compartments, said baffle serving to hold condensate removed from air cooled by said structure, and means to conduct such condensate from said baffle outside said storage space.

9. A refrigerator having a thermally insulated storage space, an absorption refrigeration system including an evaporator providing a path of flow for refrigerant which evaporates in the presence of an auxiliary agent, partitions forming a plurality of heat conducting compartments in contiguous side by side relation immediately beneath the ceiling of said storage space, the bottom of said compartments forming a subceiling for said storage space from one lateral side to the opposite lateral side thereof, said evaporator having a plurality of sections arranged in series with one section in each compartment to effect cooling thereof, said refrigerant evaporating in the auxiliary agent at a low temperature in one of said sections and at a higher temperature in another of said sections, and structure including a plurality of vertically disposed fins or plates secured to the bottom of said compartments and extending from one lateral side to the opposite lateral side of said storage space for causing circulation of air therein in such a manner that an air stream passes first over a part of said fins at one temperature and then over a part of said fins at a lower temperature.

10. A refrigerator as set forth in claim 9 in which said structure includes a horizontally disposed baffle plate, beneath said fins, means for insulating said compartments from the walls of said space, and means for draining condensate dripping on said baffle from said fins.

11. A refrigerator having a thermally insulated storage space, an absorption refrigeration system including an evaporator providing a path of flow for refrigerant which evaporates in the presence of an auxiliary agent, partitions form-

ing a plurality of heat conducting compartments in contiguous side by side relation, immediately beneath the ceiling of said storage space and open at the front, the bottom of said compartments forming a sub-ceiling for said storage space from one lateral side to the opposite lateral side thereof, the part of said bottom associated with a first compartment being at a lower level and the part associated with another of said compartments being at a higher level, said evaporator having a plurality of sections arranged in series with one section in each compartment to effect cooling thereof, closure means for the openings of said compartments, said refrigerant evaporating into auxiliary agent at a low temperature in said first section and at a higher temperature in another of said sections, and structure including a plurality of vertically disposed fins or plates secured to the bottom of said compartments and extending from one lateral side to the opposite lateral side of said storage space for causing circulation of air in said space, the bottom edges of said fins or plates being substantially horizontal and of greater depth at the portion directly beneath the part of the bottom at a higher level.

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