Feb. 7, 1939. W. G. KÖGEL 2,146,076

REFRIGERATION

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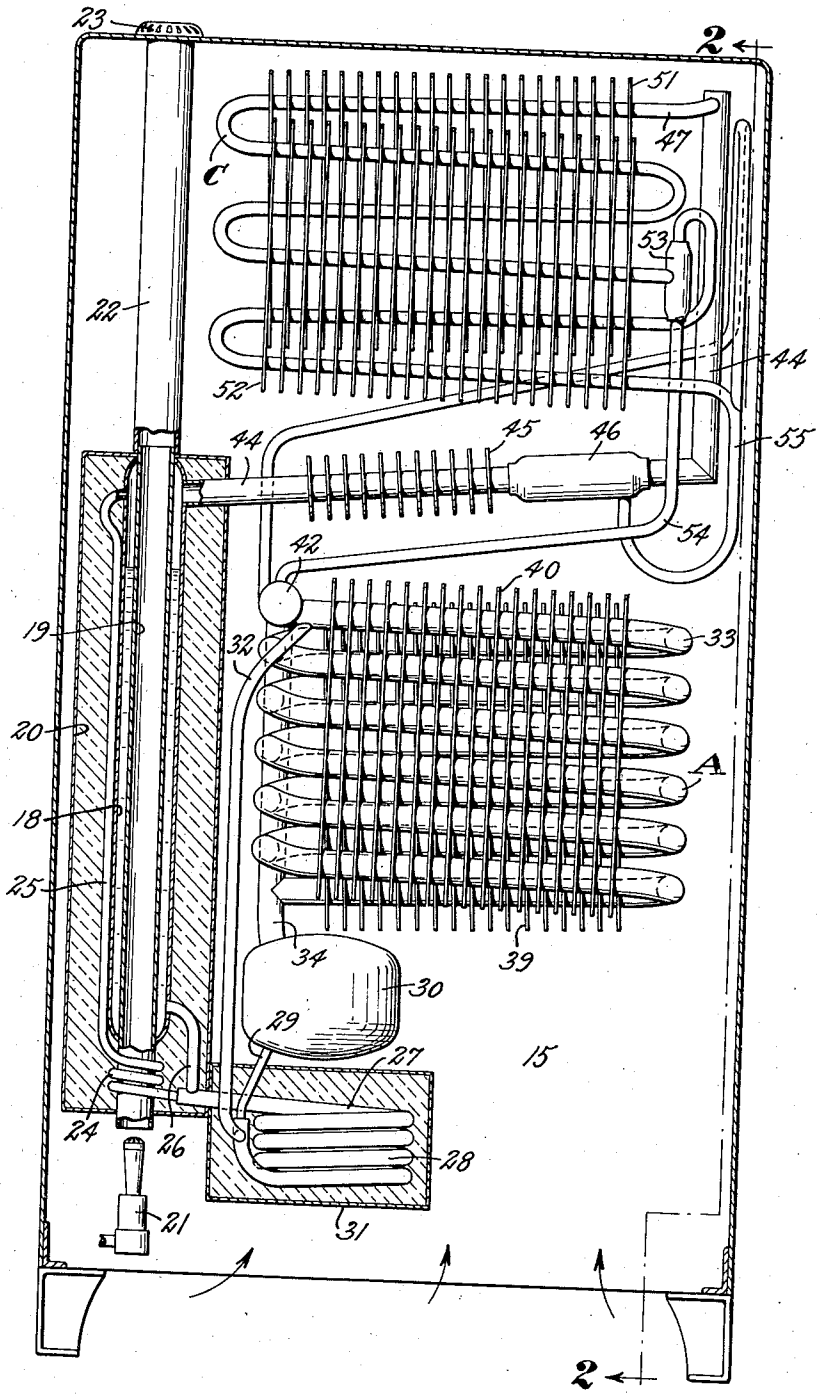


Fig. 1.

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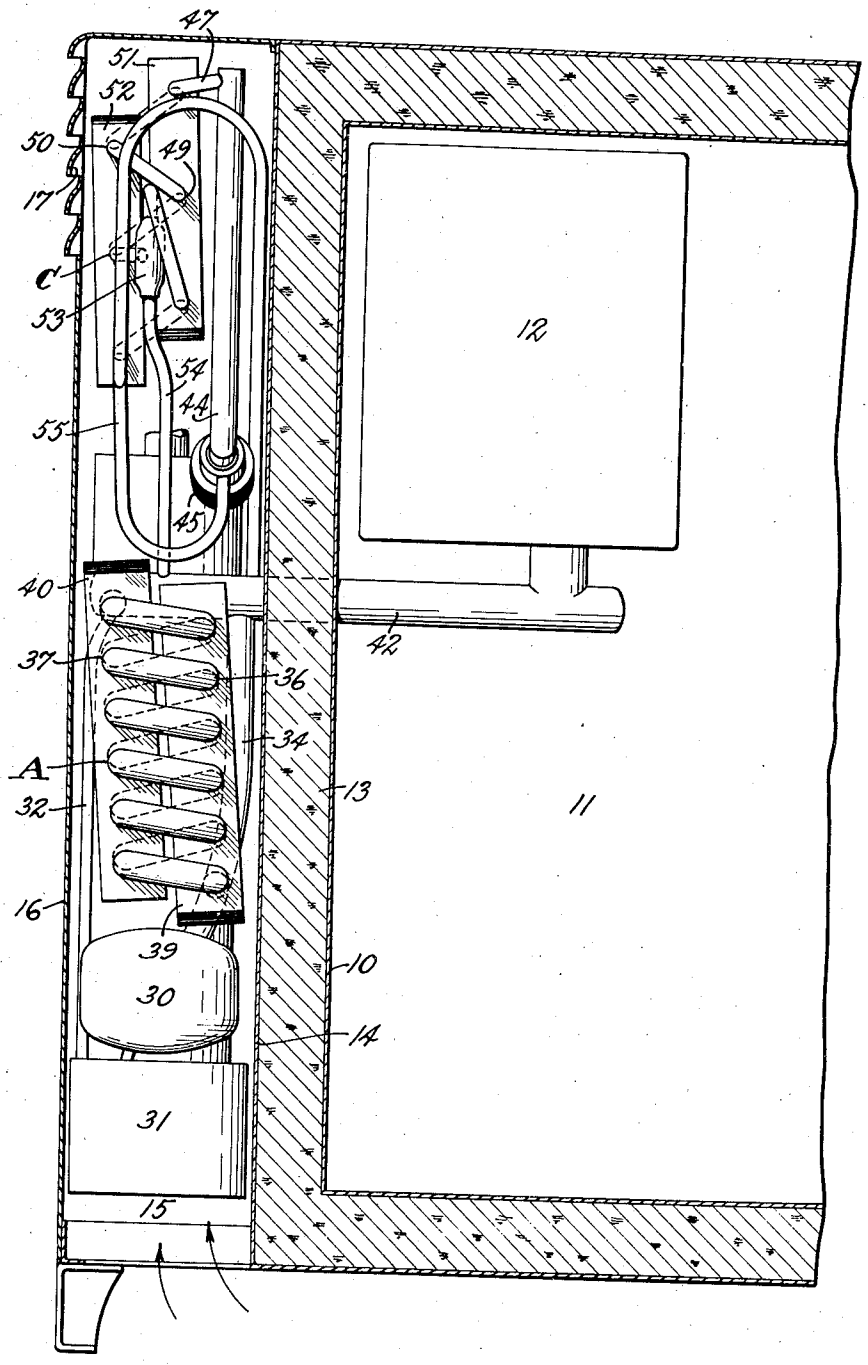


Fig. 2.

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UNITED STATES PATENT OFFICE

2,146,076

REFRIGERATION

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Application September 12, 1934, Serial No. 743,656
In Germany September 30, 1933

15 Claims. (Cl. 62—119.5)

My invention relates to refrigeration and more particularly to the dissipation of heat from an artificial refrigerating system. Still more particularly my invention relates to refrigerating systems of the kind using an inert gas into which the refrigerant diffuses in its vaporization.

The principal object of the invention is to provide an absorber or other heat rejecting member of a refrigerating system, and more particularly for systems of the no moving part type in which the manufacture is facilitated while at the same time heat transfer is improved.

A further object of the invention is to provide better heat transfer between the heat rejecting part or parts of a refrigerator and the air of a natural draft flue for conducting away the rejected heat.

The invention will be understood by reference to the following description taken in conjunction with the accompanying drawings which form a part of this specification, and of which:

Fig. 1 is a rear view of a refrigerator with the back plate of the flue removed; and

Fig. 2 is a vertical transverse sectional view taken on the line 2—2 of Fig. 1.

The refrigerator includes a liner 10 enclosing a food space 11 access to which may be had through the usual door or doors. Within the space 11 is an evaporator 12. Surrounding the liner is insulation 13 and around the insulation is a shell 14.

At the rear of the refrigerator is an apparatus compartment 15 which also constitutes a flue for upward flow of cooling air. The back of the flue is formed by a substantially solid plate 16 which has louvres 17 for the outlet of cooling air. Air is admitted to the flue 15 at the bottom and due to the heat given off by the refrigerating apparatus, flows upwardly through the flue and out at the top through the louvres 17 cooling the heat rejecting parts of the refrigerator.

The apparatus includes a generator 18 which may be vertically disposed in the space 15 and which has a central flue pipe 19. The generator is enclosed in an insulation casing 20. A burner 21 is provided below the flue 19 and directs a flame into the flue to heat the generator. The flue is continued upwardly at 22 and has an outlet 23 in the top of the cabinet. Surrounding the lower part of the flue 19 which is extended outside of the generator proper is a thermosyphon coil 24 wound around the flue in good thermal contact. A thermosyphon riser tube 25 extends upwardly from the top of coil 24 to the upper or vapor space of generator 18. A conduit 26 is connected to the lower part of the generator and to the outer conduit 27 of a liquid heat exchanger 28. An inner conduit 29 of the liquid heat exchanger 28 extends from the bottom of an absorber reservoir 30 to the bottom of coil 24. Heat exchanger 28 is enclosed in an insulation casing 31. A pipe 32 connects the outer pipe 27 of the liquid heat exchanger with the upper part of an absorber designated generally by reference character A.

The absorber is situated in the flue 15 and consists of a coil of relatively large sized tubing 33 adapted for continuous downflow of liquid therethrough. The lower end of the absorber A is connected to conduit 34 which is in turn connected to the absorber vessel 30.

The absorber includes a plurality of banks of tubes or tube portions as best shown in Fig. 2. While any number of banks may be provided, for the particular refrigerator shown there are two banks, 36 and 37. Each bank includes a plurality of tube portions which are preferably straight. The tube portions of bank 36 are inclined slightly from the horizontal in one direction and the tube portions of bank 37 are inclined slightly from the horizontal in the opposite direction. The lower end of any straight tube portion is slightly above the high end of the adjacent tube portion in the adjacent bank and the return bends connecting the adjacent tubes of different banks are inclined slightly to the horizontal. It will thus be seen that there is a slight and continuous decline throughout the absorber tube.

Fins are provided on the absorber banks. In accordance with the invention separate fins are used for the individual banks. The fins on bank 36 are lettered 39 and the fins on bank 37 are lettered 40. Fins 39 are perpendicular to the tubes on bank 36 while fins 40 are perpendicular to the tubes of bank 37. Thus the fins are inclined to the vertical as shown in Fig. 1. The fins 40 are inclined to one side and the fins 39 are inclined to the other side. Furthermore, the banks 36 and 37 are in planes which are inclined to the vertical as best seen in Fig. 2. These planes are, however, parallel to facilitate manufacture, though this is not entirely necessary. It will be seen that in vertical projection the fins overlap.

The absorber may be made up by forming a series of U-bends with the legs slightly off parallel to allow for the ultimate inclination. The fins can be then threaded on to the legs of the U-bends and are perpendicular thereto whereby

they can be readily secured tightly to the tubes as by being forced thereon or by expanding the tubes after the fins are on the tubes. Due to this arrangement good contact can be had with the tubes and at the same time manufacture is facilitated. Furthermore, an improved heat transfer between the tubes and the air is obtained as will be later explained.

The upper part of the absorber A is connected to one space of a gas heat exchanger 42 which is in turn connected with the evaporator 12. The conduit 34 is connected to a separate space of the gas heat exchanger 42 and connected to a different part of the evaporator. The gas heat exchanger and evaporator may be of various forms and the details of construction need not be given for purposes of the present invention. For more detailed information as to this general type of system reference may be made to U. S. Patent No. 1,609,334 granted Dec. 7, 1926, on an application of von Platen and Munters.

A refrigerant vapor pipe 44 is connected to the upper part of the generator 18. Fins 45 are disposed on pipe 44 to give an initial rectification of the generator vapor. Surrounding conduit 44 is a second rectifier jacket 46 which is supplied with condensed refrigerant from the condenser. Conduit 44 extends upwardly and is connected at the top of the refrigerator to condenser pipe 47. The condenser consists of the pipe 47 having fins thereon and is generally designated by reference character C. The condenser may be made in the same way as the absorber, although it is understood that the invention may be applicable either to the condenser or the absorber individually. The condenser shown includes two banks of tubes or tube portions 49 and 50. The tubes of these banks are inclined oppositely to the horizontal to provide flow of liquid downwardly through the condenser. Bank 49 has fins 51 thereon and bank 50 has fins 52 thereon. Fins 51, as can be seen in Fig. 1, are inclined slightly from the vertical in one way and fins 52 are inclined slightly from the vertical in the other way. The banks 49 and 50 are themselves in planes which are inclined from the vertical as shown in Fig. 2 and the fins may overlap vertically as in the case of the absorber fins. The condenser drains into a chamber 53 from which a liquid conduit 54 carries liquid to the evaporator through the gas heat exchanger 42. A conduit 55 is connected to vessel 53 and is connected to rectifier jacket 46 for supplying liquid ammonia thereto. Vapor generated in the rectifier jacket 46 is conducted back to the condenser in known manner, as by being conveyed through conduit 44.

Air is admitted to the bottom of flue 15 and due to the heat given off is raised by natural draft through the flue 15. The air passes over the absorber and condenser surfaces and withdraws the heat to be rejected from the system. If some of the air be followed in its upward course it will be seen that it will strike the fins 40 and its course will be changed from the vertical to an inclined course. As this air rises it then comes in contact with the fins 39 and the course is changed in the opposite direction. Thus the air is given a sort of corkscrew path of travel and the air is thoroughly stirred, which gives good heat transfer. Even though the same air does not contact the fins of the different banks, the stirring and twisting of the air will be obtained due to the forcing of different parts of the air in different courses angled from the vertical. The same effect takes place in the condenser, the air being twisted off the vertical on one side and twisted off the vertical on the other. This gives a complete stirring of the gases and prevents layers of air forming.

It will be appreciated that the condenser can be made in the same manner as the absorber. Either the banks can be made up separately and the return bends welded on to the straight portions of the tubing to which the fins have been applied or the tubing can be made up in the form of U-bends, the fins applied to the separate banks, and then the remaining return bends welded on. It is also possible to apply the fins on the tubing with the return bends perpendicular to the planes of the fins and then twist the tubing before the fins are pressed into contact with the tubing. The tubing may be expanded against the fins by drawing a steel ball through the tubing.

While the general internal operation of the system is the same as in other systems of this character, it may be well to explain the internal cycle. Heat applied to the generator 18 separates refrigerant vapor from solution. The refrigerant may be ammonia, the solvent may be water, and the auxiliary gas may be hydrogen. Refrigerant vapor passes through conduit 44 and entrained water vapor is condensed in the inclined conduit 44 due to the rectifier fins 45 and the rectifier jacket 46, the condensed water returning back through the tube 44 to the generator. Substantially pure refrigerant vapor passes to the condenser and is there condensed. The liquid flows downwardly into vessel 53 and thence through the conduit 54 and through the gas heat exchanger into the evaporator 12. The evaporator may include the usual ice trays. In the evaporator the refrigerant evaporates and diffuses into the inert gas. The gas mixture thus formed, which may be ammonia and hydrogen, passes through the gas heat exchanger and into the lower part of the absorber. The gas mixture passes upwardly through the absorber in contact with a downwardly flowing stream of liquid. The weak liquid, namely water deprived as much as possible of its content of refrigerant, is supplied to the absorber through conduit 32. The liquid flows downwardly through the pipe of one bank then across to the other bank and back to the first bank, and so on gradually down through the coil. If desired wire mesh or other capillary material or distributing material may be employed in the absorber to hinder the flow of liquid or to increase the available contact surface between gas and liquid. The weak absorption liquid absorbs the refrigerant vapor and releases the inert gas. The weak inert gas passes upwardly through the absorber and through the gas heat exchanger 42 into the evaporator to become enriched by further refrigerant vapor.

The enriched liquid flows from the bottom of the absorber into the vessel 30 and thence flows through conduit 29 and is lifted by the thermosyphon coil 24 to the generator. By this means a sufficient height is maintained in the generator so that the weak liquid can flow through conduits 26, 27 and 32 to the upper part of the absorber.

Various changes may be made without departing from the spirit or scope of the invention. The louvres 17 may, for example, be disposed in the top of the flue 15 instead of on the side. The flue gases may be discharged into the flue 15. Various changes may be made in the construc-

tion of the apparatus. It is not absolutely necessary that separate fins be used on the different banks but it will be appreciated that the utilization of the same fins would be less adaptable to manufacture. For example, fins might be employed which could span the banks and which would have weak intermediate parts whereby the absorber tubes could be twisted to give the different angularity of the extended surface on the different banks. While flat plates are used for the fins it will be appreciated that these may be corrugated vertically, transversely, or in any other manner to further stir up the flowing air.

What I claim is:

1. In a refrigerator, walls forming a vertical air flue and a heat rejecting member in said flue including a plurality of groups of fins, the fins of one group being inclined from the vertical one way with respect to a given vertical plane, the fins of an adjacent group being inclined from the vertical the other way with respect to the same vertical plane, and the fins of both groups being inclined from the vertical with respect to a plane at right angles to the first-mentioned plane.

2. In a refrigerator, walls forming an air flue and a heat rejecting member in said flue including a plurality of banks of tubes arranged in parallel with respect to flow of air through the flue, and separate groups of fins on the different banks, the groups of fins being differently inclined to the general direction of flow of air through the flue.

3. In a refrigerator, walls forming an air flue and a heat rejecting member in said flue including a plurality of banks of tubes, and separate groups of fins on the different banks, said banks being arranged in parallel with respect to flow of air in the flue and the fins of one group inclined with respect to the fins of another group.

4. In an absorption refrigeration apparatus, a gas heat exchanger, a storage vessel, a vertical conduit extending between said exchanger and said vessel, and an absorber coil having one end connected to said conduit and one end connected to said exchanger, said coil having fins thereon inclined to the vertical.

5. In an absorption refrigeration apparatus, a gas heat exchanger, a storage vessel, a conduit extending vertically between said exchanger and said vessel, and an absorber coil having one end connected to said conduit and one end connected to said exchanger, said coil having fins thereon inclined one way from the vertical and fins thereon inclined the other way from the vertical.

6. In an absorption refrigeration apparatus, a gas heat exchanger, a storage vessel, a conduit extending vertically between said exchanger and said vessel, and an absorber coil having one end connected to said conduit and one end connected to said exchanger, said coil including a plurality of banks of tubes and oppositely inclined fins on the different banks.

7. Refrigerating apparatus including a generator, a condenser, an evaporator, an absorber, and members connecting the aforesaid parts, to form a complete system for circulation of a refrigerant, an absorption liquid and an inert gas, members forming an air passage, said absorber being positioned in said air passage, and said absorber including a plurality of banks of tubes arranged in parallel with respect to flow of air in said passage, the banks being oblique to the general line of air flow through the passage and the tubes of one bank being oblique to the tubes of another bank, and air cooling fins on said tubes perpendicularly to the tubes.

8. Refrigerating apparatus including a generator, a condenser, an evaporator, an absorber, and members connecting the aforesaid parts to form a complete system for circulation of a refrigerant, an absorption liquid and an inert gas, members forming an air passage, said condenser being positioned in said air passage, and said condenser including a plurality of banks of tubes arranged in parallel with respect to flow of air in said passage, the banks being oblique to the general line of air flow through the passage and the tubes of one bank being oblique to the tubes of another bank, and air cooling fins on said tubes perpendicular to the tubes.

9. A refrigerator including walls forming a thermally insulated storage compartment and a relatively narrow natural draft air flue at one side of said storage compartment, and refrigeration apparatus including a boiler, a condenser, an evaporator and an absorber interconnected for flow of refrigerant, absorption liquid and inert gas, said absorber being disposed in said flue and comprising tubing adapted for continuous downward flow of liquid, different parts of said tubing being differently inclined, and fins on the differently inclined parts of the absorber tubing, the fins on tubing of one inclination being oblique to and alongside of fins on tubing of another inclination, whereby air passing over said tubing is diverted in a plurality of parallel paths having different directions, and connections to supply and withdraw absorption liquid and inert gas to and from said tubing.

10. Refrigerator including walls forming a thermally insulated storage compartment and a relatively narrow apparatus compartment at one side of said storage compartment, substantially coextensive therewith in height, and forming a flue adapted for upward flow of air therethrough, and refrigeration apparatus including an absorber which is relatively flat and located in said flue formed by the narrow apparatus compartment and cooled by substantially vertically flowing air therein, said absorber comprising banks of tubes, said banks being located substantially side by side, each bank having a group of fins inclined oppositely to another.

11. Refrigeration apparatus including a generator, a condenser, an evaporator, an absorber, and members connecting the aforesaid parts to form a complete system for circulation of a refrigerant, an absorption liquid, and an inert gas, members forming an air passage, said absorber being positioned in said air passage, and heat transfer surface members forming part of said absorber, said members being arranged in parallel with respect to air flow at a given cross sectional plane transverse to the general line of air flow, and said members which are arranged in parallel with respect to air flow being oppositely inclined relative to and at the same said cross sectional plane to divert air being heated in said passage in a plurality of directions from the general line of air flow therethrough.

12. Refrigeration apparatus including a generator, a condenser, an evaporator, an absorber, and members connecting the aforesaid parts to form a complete system for circulation of a refrigerant, an absorption liquid, and an inert gas, members forming an air passage, said absorber being positioned in said air passage, and heat transfer surface members forming part of said absorber, said members being arranged in par-

allel with respect to air flow at a given cross sectional plane transverse to the general line of air flow, and said members which are arranged in parallel with respect to air flow being oppositely inclined relative to and at the same said cross sectional plane to divert air being heated in said passage in a plurality of oblique directions from the general line of air flow therethrough.

13. Refrigeration apparatus including a generator, a condenser, an evaporator, an absorber, and members connecting the aforesaid parts to form a complete system for circulation of a refrigerant, an absorption liquid, and an inert gas, members forming an air passage, said absorber being positioned in said air passage, and a plurality of groups of heat transfer surface members forming part of said absorber, said groups being arranged in parallel with respect to air flow at a given cross sectional plane transverse to the general line of air flow, and said groups which are arranged in parallel with respect to air flow being oppositely inclined relative to and at the same said cross sectional plane to divert air being heated in said passage in a plurality of oblique directions from the general line of air flow therethrough.

14. In absorption refrigeration apparatus including an evaporator and an absorber through which an inert gas is circulated, the improvement which consists in flowing absorption liquid in a continuously downward path of flow, cooling said path of liquid flow by air, and causing the air in its passage over said path of liquid flow to be deflected into a plurality of parallel paths of flow, said paths of flow being oblique with respect to the general direction of air flow and at different angles with respect to each other at their places of parallel flow.

15. In absorption refrigeration apparatus including an evaporator and an absorber through which an inert gas is circulated, the improvement which consists in flowing absorption liquid in a continuously downward path of flow, cooling said path of liquid flow by natural draft, and deflecting flow of air in its passage over said path of liquid flow in a plurality of parallel paths of different directions relative to each other and oblique to the general line of air flow at their places of parallel flow.

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