Sept. 28, 1954 S. M. BACKSTROM 2,690,058

CONDENSER ARRANGEMENT FOR ABSORPTION REFRIGERATION APPARATUS

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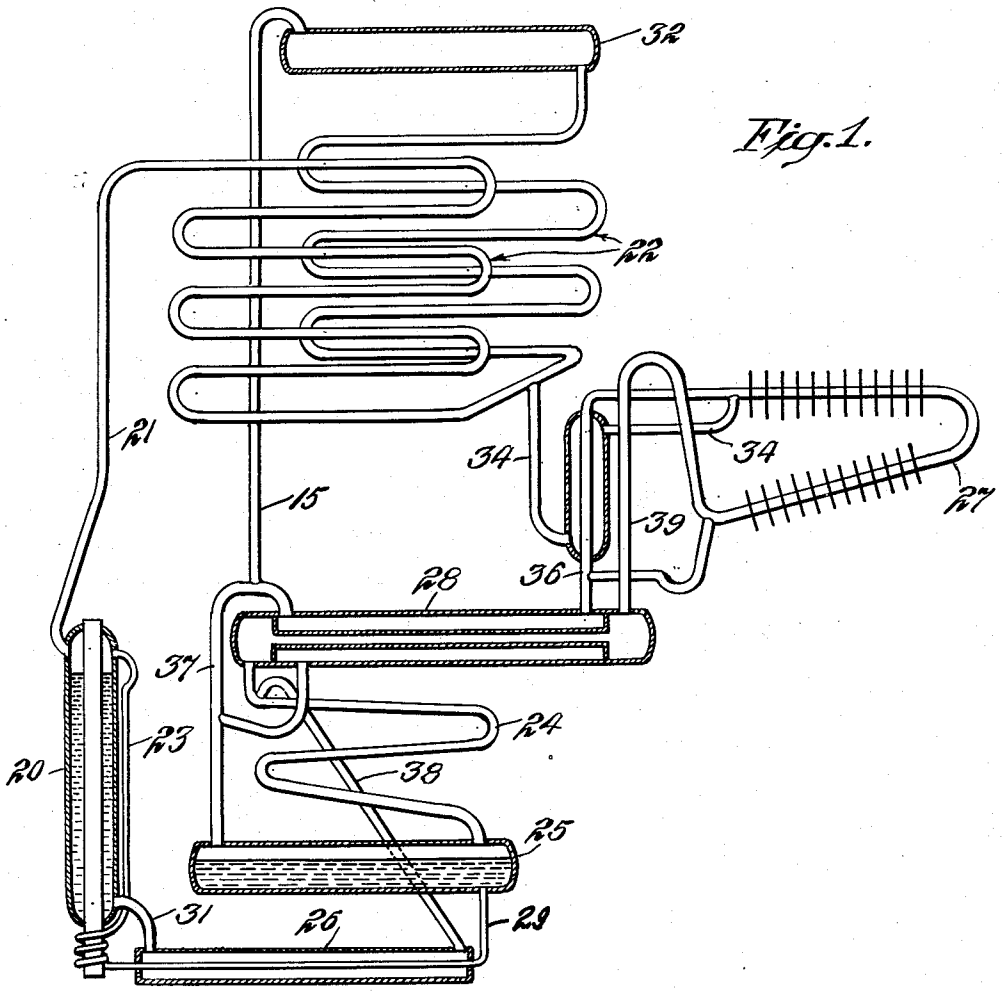


Fig. 1.

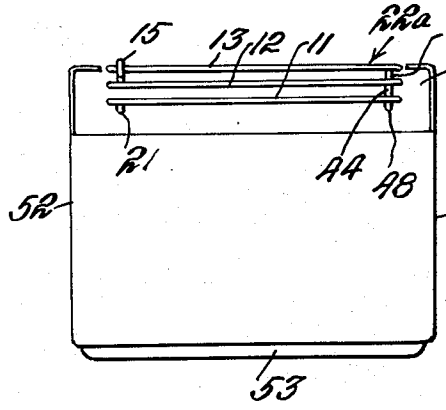


Fig. 2.

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Fig. 3.

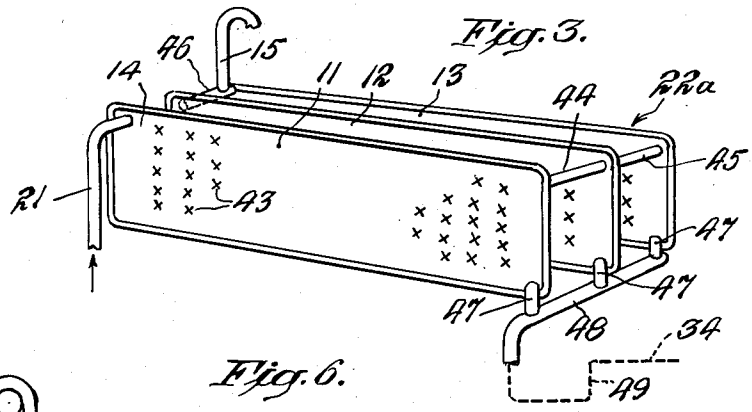


Fig. 6.

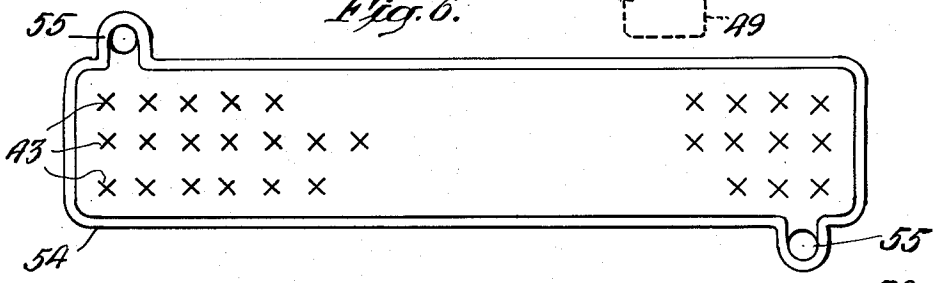


Fig. 7.
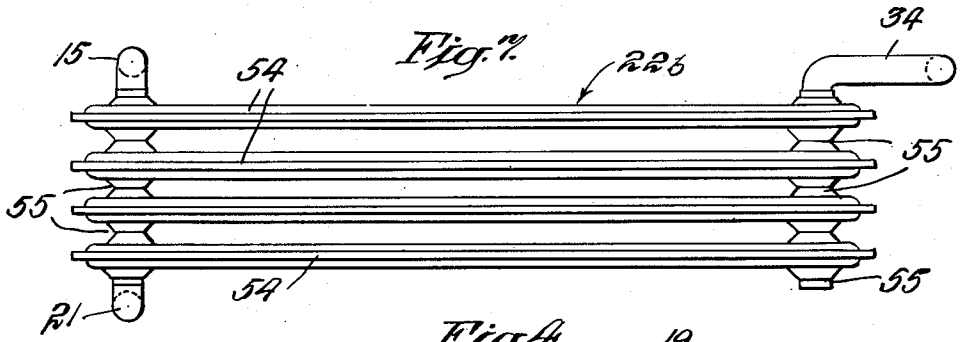


Fig. 4.



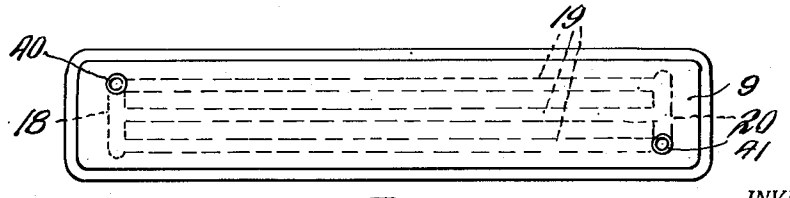


Fig. 5.

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2,690,058

CONDENSER ARRANGEMENT FOR ABSORPTION REFRIGERATION APPARATUS

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Claims priority, application Sweden April 17, 1945

11 Claims. (Cl. 62—119.5)

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This invention relates to air-cooled absorption refrigeration apparatus employing an inert gas as a pressure equalizing medium and is especially concerned with apparatus of this kind provided for household or domestic use. More particularly, the invention is concerned with condenser arrangements for absorption refrigeration apparatus cooled by circulation of air which may be induced either by forced or natural draft.

It is an object of the invention to provide an improved condenser of this type for absorption refrigeration apparatus in which sections or units thereof disposed closely adjacent to and alongside one another are fabricated from essentially flat metallic members having a fluid passageway therebetween, such metallic members providing a relatively extensive heat dissipating surface and being capable of withstanding the relative high internal pressure of the apparatus.

Another object of the invention is to provide a condenser for absorption refrigeration apparatus which is formed of contacting metallic sheets and connected in such manner that circulation of refrigerant vapor in the passageway therebetween is effectively promoted by the refrigerant which in vapor phase is denser than the inert gas or pressure equalizing medium.

A further object is to provide in a vertically extending space at the rear of a household refrigerator an air-cooled condenser for absorption refrigeration apparatus in which units or sections thereof are formed from metal sheets having fluid passageways therebetween, the sheets being compactly arranged together and vertically disposed in such space to promote upward flow of cooling air which is induced by natural draft.

The above and other objects and advantages of the invention will be more fully understood upon reference to the following description and accompanying drawing forming part of this specification, and in which:

Fig. 1 illustrates more or less diagrammatically absorption refrigeration apparatus of the inert gas type to which the invention is applicable;

Fig. 2 is a top plan view of a household refrigerator having a rear flue space arranged to receive a condenser for absorption refrigeration apparatus like that shown in Fig. 1 and embodying the invention;

Fig. 3 is an enlarged perspective view of the condenser diagrammatically shown in Fig. 2;

Figs. 4 and 5 are views of the inner and outer faces of the rear wall or plate and front wall or

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plate, respectively, of the foremost section or compartment of the condenser shown in Fig. 3; and

Figs. 6 and 7 are side and top plan views, respectively, of a condenser illustrating another embodiment of the invention.

In Fig. 1 is diagrammatically illustrated an absorption refrigeration system of a uniform pressure type containing an inert pressure equalizing gas. In such apparatus refrigerant vapor is expelled from absorption liquid in a boiler or vapor expulsion unit 20 by heating, and, together with vapor passing from the upper end of a vapor lift tube 23, passes through a conduit 21 to a condenser 22. The refrigerant vapor, such as ammonia, is liquefied in the condenser and flows through a conduit 34 into an evaporator 27 in which the liquid refrigerant evaporates and diffuses into an inert gas, such as hydrogen, to produce a refrigerating effect.

The resulting gas mixture of refrigerant and inert gas flows from the upper part of evaporator 27 through a conduit 36, outer passage of a gas heat exchanger 28 and conduit 37 to an air-cooled absorber including looped coil 24 and vessel 25. In the absorber refrigerant is absorbed from the gas mixture into absorption liquid, such as water, which is delivered thereto through a conduit 38. The inert gas is returned from the absorber to the evaporator 27 in a path of flow which includes the inner passage of gas heat exchanger 28 and a conduit 39.

The enriched absorption liquid is conducted through a conduit 29 and inner passage of liquid heat exchanger 26 to the lower coiled end of vapor lift tube 23 which is in thermal contact with heating flue of the boiler 20 at the lower heat input end thereof. Absorption liquid weak in refrigerant returns from boiler 20 to the absorber in a path of flow including conduit 31, the outer passage of the liquid heat exchanger 26 and conduit 38. The outlet end of condenser 22 is connected to a pressure vessel 32 which in turn is connected by a conduit 15 to the gas circuit, as to the conduit 37, for example.

In accordance with this invention it is proposed to employ in absorption refrigeration apparatus of the kind shown in Fig. 1 and just described a condenser 22a formed of sheet metal members which are compactly arranged to provide a number of compartments alongside one another, such sheet metal members being substantially flat and presenting relatively extensive heat dissipating surfaces. In a condenser construction of this kind air can pass in intimate

contact with the sheet metal members, especially in the gaps between adjacent compartments, so that natural draft circulation of air can be effectively promoted in a vertically extending compartment in which the condenser and absorber are usually positioned and mounted.

As shown in Fig. 3, the condenser 22*a* includes three sections or compartments 11, 12 and 13, respectively, which are arranged alongside one another. The section or compartment 11 is made of sheet metal members 9 and 10 which are illustrated in Figs. 4 and 5, respectively. The sheets 9 and 10 are formed with horizontally extending grooves 19 which are distributed in a vertical range and disposed at three different levels, and also formed with vertically extending grooves 18 and 20 which communicate with the ends of the grooves 19. Openings 40 and 41 are formed in the sheet metal member 9 and an opening 42 is formed in the sheet metal member 10. After the sheet metal members 9 and 10 are formed in the manner just described, they are placed together so that the corresponding grooves 18, 19 and 20 are in alignment and the concave sides face each other to form a plurality of horizontally extending fluid passageways which are connected in parallel by vertically extending passageways which may be referred to as end headers.

After the flat members or sheets 9 and 10 are placed together the peripheral edges thereof are united together, as by welding, for example. In addition, these flat members may be spot-welded together at a number of spaced apart regions, as indicated at 43 in Fig. 3, in order to structurally reinforce the individual compartments or sections within which the internal pressure may be as high as 20 atmospheres when employed as the condenser of an absorption refrigeration apparatus of a type like that illustrated in Fig. 1.

The compartments or sections 12 and 13 are formed from sheet metal members in a manner similar to the section 11 and provided with suitable openings to connect the compartments together in the manner shown in Fig. 3. As shown, refrigerant vapor is conducted from the vapor expulsion unit or boiler through conduit 21 which is connected to sheet metal member 14 at the region of the opening 40. Conduit 44 is connected to the plate 9 at the opening 42 to connect the upper end of an end header in compartment 11 and the upper end of an end header in compartment 12. Similarly, conduit 45 connects the upper ends of end headers at one end of compartments 12 and 13, and conduit 46 connects the upper ends of the end headers at the opposite end of compartments 12 and 13. Conduits 47 are connected to the lower ends of end headers in compartments 11, 12 and 13 and to a common conduit 48 formed with a U-trap 49 which communicates with conduit 34.

When the refrigeration apparatus in which condenser 22*a* is connected is initially started following a shut-down period, the compartments 11, 12 and 13 essentially are filled with inert gas which may be hydrogen, as previously explained. By introducing refrigerant vapor, such as ammonia, for example, through conduit 21 into the upper part of the end header formed by the complementary grooves 18, a column of such refrigerant vapor is formed in such end header which produces a force within the condenser system to promote circulation of refrigerant vapor. This is so because the density of ammonia is greater than that of hydrogen and the compartment 11 will be filled upwardly from the bottom thereof with ammonia vapor, the hydrogen gas being displaced by the ammonia vapor from one horizontally extending passageway after another and eventually being forced through conduits 44 and 45 into the passageways formed in the ends of the compartments 12 and 13. In a similar manner, refrigerant vapor is initially introduced through conduits 44 and 45 into vertical end headers of the compartments 12 and 13. Accordingly, the column of refrigerant vapor which is denser than the inert gas promotes circulation of refrigerant vapor when some of the condenser passageways are filled with inert gas and the refrigerant vapor is tending to seek a path of flow which ultimately leads to the outlet end of each condenser section.

When adequate cooling of the condenser 22*a* is effected, it is possible that such a large portion of the quantity of refrigerant vapor in the condenser may condense and liquefy in the compartment 11 and lowest passageways in the compartments 12 and 13, and the partial pressure of the refrigerant vapor in the uppermost passageways in the compartments 12 and 13 will not be sufficiently high for condensation to be effected therein. Nevertheless, the circulation of refrigerant vapor which is promoted in the manner described above gradually brings into operation the necessary number of condenser passageways for the proper functioning of the condenser. The uppermost passageways of the compartments 12 and 13, when they remain filled with inert gas, function to a certain extent as a pressure equalizing chamber or space in the same manner as the pressure vessel 32 in Fig. 1.

When inert gas is displaced by refrigerant vapor in the compartments 12 and 13, such inert gas passes into conduit 46 connecting the upper ends of the vertical passages or end headers at the ends of the compartments removed from the conduits 44 and 45. The conduit 46 in turn is connected to conduit 15 which is connected to the gas circuit in the same manner as the conduit 15 in Fig. 1.

In the embodiment being described and shown in Figs. 3, 4 and 5, refrigerant vapor is conducted to the extreme upper end of the vertical passageway formed by the complementary grooves 18 in sheets 9 and 10. It is to be understood that such refrigerant vapor may be introduced into each compartment at a region of an end header which is located between the connection of the highest and next highest horizontal passageway. In any event refrigerant vapor desirably is introduced into the inlet end header at a region which is above at least half of the different levels in which the horizontal passageways are disposed.

The horizontal passageways desirably are inclined downwardly toward the ends of the compartments or sections having the conduit connections 48, thereby facilitating flow of liquid refrigerant formed in the condenser to the end headers to which the conduits 47 are connected. Liquid refrigerant flows by gravity through conduit 48 and a U-trap 49 which is in communication with conduit 34, the latter being arranged to conduct liquid refrigerant to the evaporator in the same manner as the conduit 34 shown in Fig. 1.

As shown in Fig. 2, the condenser 22*a* desirably is mounted and positioned in a vertically extending space 50 formed by the lateral side walls 51 of a refrigerator cabinet 52 having a front access opening 53. Other parts of the absorption refrigeration apparatus also are

mounted in the space 50, such as the absorber vessel 25 and absorber coil 24 of Fig. 1, for example. In such case the absorber parts are usually mounted and positioned in the vertical space 50 beneath the condenser.

During operation of the refrigeration apparatus, refrigerant vapor is condensed in the compartments 11, 12 and 13 due to the cooling influence of the surrounding air which passes over the surfaces of the sheet metal members, the heat of condensation being effectively given up to the cooling air. Heat is also liberated in the absorber coil 24 and absorber vessel 25 due to absorption of refrigerant vapor into absorption liquid. Such heat of absorption is given up to surrounding air which passes over the surfaces of the absorber parts. Air heated as a result of passing over the surfaces of the absorber coil and vessel can freely rise in the space 50 at the rear of cabinet 52 and then pass in intimate contact with the flat surfaces of the sheet metal members employed on the construction of condenser 22*a*.

The compartments 11, 12 and 13 may extend substantially from one lateral side wall 51 to the opposite side wall. The gaps or spaces between the individual compartments form passages through which circulation of surrounding air over the sheet members is promoted due to upward flow of air in space 50 which is induced by natural draft. In this way an upward flue effect between the individual compartments and also in the space at the rear insulated wall of the cabinet is produced for adequate circulation of cooling air to enable the condenser to function properly with the heat dissipating surfaces provided by the sheet metal members, thereby avoiding the necessity of providing additional heat dissipating surfaces, such as fins or other heat transfer elements. In addition, surrounding cooling air which is unheated by previous dissipating of heat of absorption can circulate and pass over the extensive heat dissipating surface formed by the outside sheet of the condenser compartment 13.

The condenser 22*a* provides an extremely compact construction and is simple to manufacture in contrast to conventional condensers employing many tubes and fin members fixed thereto. The grooves forming the fluid passageways may be relatively small in depth because the passageways are arranged in such manner that circulation of refrigerant vapor and displacing of inert gas by such vapor in the condenser compartments is effected without any danger of the individual passageways being blocked by liquid condensate.

In Fig. 6 is illustrated another form of condenser section or compartment 54, a number of which may be connected together in the manner shown in Fig. 7. The metal members forming the condenser sections 54 are generally like the members shown in Figs. 3, 4 and 5 and differ therefrom in that ears or lugs 55 are provided at the connecting openings. The ears or lugs 55 of adjacent condenser sections abut one another when they are assembled together and form continuous passageways therethrough to which other conduits of the refrigeration apparatus are connected in the same manner shown in Fig. 3 and described above.

The condenser 22*b* of Fig. 7 provides compartments alongside one another into which refrigerant vapor is introduced at the same ends adjacent the connection of conduit 21 to one of the compartments. The condenser 22*b* is generally like a heating radiator in which adjacent compartments are connected at their upper ends to establish vapor communication therebetween and at their lower ends to enable condensate to flow by gravity therefrom. With such an arrangement the heavier refrigerant vapor promotes circulation in the compartments and vapor flow will be established in the compartments 54 which brings about an equalization of the loading of the condenser resulting from inert gas being displaced therefrom into the vent conduit 15.

In condensers of the kind embodying the invention and illustrated in Figs. 3 to 7, it is essential to locate the vent connection at a region sufficiently high in the condensing system so that the quantity of inert gas which remains trapped above such region will be insignificant. Further, the condensing system or structure in each instance should be mounted and positioned so that internal circulation of refrigerant vapor will be promoted due to the difference in density of the refrigerant vapor and inert gas, whereby an increasingly greater part of the condensing system readily will be made available to effect proper functioning of the system.

This application is a continuation-in-part of my application Serial No. 660,054, filed April 6, 1946, now Patent No. 2,619,809, granted December 2, 1952.

While several embodiments of the invention have been shown and described, I do not wish to be limited to the particular constructions set forth and intend in the following claims to cover all changes and modifications which do not depart from the spirit and scope of the invention.

What is claimed is:

1. In a refrigerator comprising a cabinet including structure providing a vertically extending space at a side thereof, absorption refrigeration apparatus containing an inert gas and having a plurality of heat dissipating parts including a condenser, said condenser comprising a plurality of plate-like units each of which includes a pair of contacting metal sheets, each pair of such sheets having the peripheral edges thereof united and a fluid passage therebetween adapted to receive refrigerant in vapor phase and from which is adapted to flow condensate formed therein, each pair of said metal sheets being subject to the internal pressure within the refrigeration apparatus, and said plate-like units being disposed in the vertically extending space and positioned therein in spaced apart relation alongside one another to provide one or more vertically extending gaps therebetween to promote upward natural draft flow of air which passes in intimate contact with the exterior surfaces of said metal sheets.

2. In a refrigerator comprising a cabinet having an outer shell providing a vertically extending space at the rear thereof, absorption refrigeration apparatus containing an inert gas and including a condenser comprising a plurality of units each including contacting metallic sheets having the edges thereof united, one of the sheets of each unit having a groove cooperating with the other of the sheets to form a passageway adapted to receive refrigerant fluid in vapor phase and from which is adapted to flow condensate formed therein, each of said units being subject to the internal pressure within the refrigeration apparatus, and said units being disposed alongside one another in said space to provide one or more vertically extending gaps to promote upward flow of air therebetween which is induced by natural draft.

3. In a refrigerator comprising a cabinet including an outer shell having spaced apart lateral

side walls, the cabinet having a vertically disposed apparatus space at the rear thereof which extends between the lateral side walls, absorption refrigeration apparatus containing an inert gas and including a condenser comprising a plurality of units each including contacting metallic sheets having the edges thereof united, one of the sheets of each unit having a groove cooperating with the other of the sheets to form a passageway adapted to receive refrigerant fluid in vapor phase and from which is adapted to flow condensate formed therein, each of said units being subject to the internal pressure within the refrigeration apparatus, said units being disposed alongside one another in the apparatus space in planes essentially parallel to the front of the cabinet to provide one or more vertically extending gaps therebetween to promote upward flow of air which is induced by natural draft, one of said units being located essentially in a vertical plane passing through the rear edge portions of the lateral side walls.

4. Apparatus as set forth in claim 3 in which the lateral side walls define the narrow sides of the vertical apparatus space and said one unit extends across such space with the spaced apart vertical edges thereof closely adjacent to the rear edge portions of the lateral side walls.

5. In a refrigerator comprising a cabinet including structure providing a vertically disposed apparatus space at a side thereof, absorption refrigeration apparatus containing an inert gas and having a plurality of heat rejecting parts including a condenser having a fluid passageway adapted to receive refrigerant in vapor phase and from which is adapted to flow condensate formed therein, said condenser including a plurality of plate-like units each comprising a pair of metallic sheets joined together at their peripheral edges and providing said fluid passage therebetween which extends essentially horizontally between the top and bottom sides of the sheets, each pair of sheets having regions at a number of different levels intermediate the top and bottom sides of the sheets and essentially parallel thereto which are in abutting relation for a major portion of the distance between the vertical sides of the sheets, each pair of sheets being united by welding at such regions along lines essentially parallel to and removed from the top and bottom sides of the sheets to reenforce each plate-like unit and enable it to withstand the internal pressure of the refrigeration apparatus to which it is subjected, and said plate-like units being disposed in spaced apart relation alongside one another to provide one or more vertically extending gaps therebetween in the vertical apparatus space to promote upward natural draft flow of air which passes in intimate contact with the exterior surfaces of the sheets.

6. Apparatus as set forth in claim 5 in which one sheet of each plate-like unit is grooved, the grooved sheet of each unit cooperating with the other of the sheets to provide the fluid passageway therebetween which extends essentially horizontally between the top and bottom sides of the sheets, the fluid passageway of each unit including portions alongside one another at opposite sides of one of the regions which is united by welding along a line essentially parallel to the top and bottom sides of the sheets.

7. Apparatus as set forth in claim 5 in which one sheet of each plate-like unit is grooved, the grooved sheet of each unit cooperating with the other of the sheets to provide the fluid passageway therebetween which extends essentially horizontally between the top and bottom sides of the sheets, the fluid passageway of each unit including at least three horizontally extending portions alongside one another and vertical end portions serving as end headers for the horizontally extending portions, the regions united by welding along lines essentially parallel to the top and bottom sides of the sheets being disposed between the three horizontally extending portions of the fluid passageway.

8. In air-cooled absorption refrigeration apparatus containing an inert gas and a refrigerant which in vapor phase is denser than the gas, a gas circuit including evaporator structure, and a vapor expulsion unit for producing refrigerant vapor, means for supplying liquid refrigerant to the evaporator structure comprising a condenser unit including a body having contacting metallic sheets whose edges are united, one of said sheets having grooves providing vertically extending passages serving as end headers which are in spaced apart relation and also providing a group of horizontally extending passages which are distributed in a vertical range and positioned at least at three different levels, one of said end headers being connected to one end of said horizontally extending passages and the other end header being connected to the opposite end of such passages, each of said end headers constituting independent means for establishing fluid communication between all of the horizontally extending passages embodied in said condenser unit and connected thereto, conduit means for conducting refrigerant vapor from the vapor expulsion unit to said one end header at a region which is above at least half of the different levels at which said horizontally extending passageways are disposed, conduit means communicating with said other end header for conducting liquid refrigerant therefrom to the evaporator structure, and conduit means communicating with the upper part of said condenser unit for venting inert gas therefrom to the gas circuit.

9. Apparatus as set forth in claim 8 in which said conduit means for refrigerant vapor conducts such vapor to said one header at a region which is above the connection thereto of at least two or more horizontally extending passages at different levels.

10. Apparatus as set forth in claim 8 in which said conduit means for refrigerant vapor conducts such vapor to said one end header at a level which is above the connection thereto of the lowest horizontally extending passage and below the connection thereto of the highest horizontally extending passage.

11. Apparatus as set forth in claim 8 in which said conduit means for refrigerant vapor conducts such vapor to said one end header at a region between the connections thereto of said horizontally extending passage at the highest level and the horizontally extending passage at the next highest level.

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