July 18, 1944. N. ERLAND AF KLEEN 2,353,715

ABSORPTION REFRIGERATING APPARATUS

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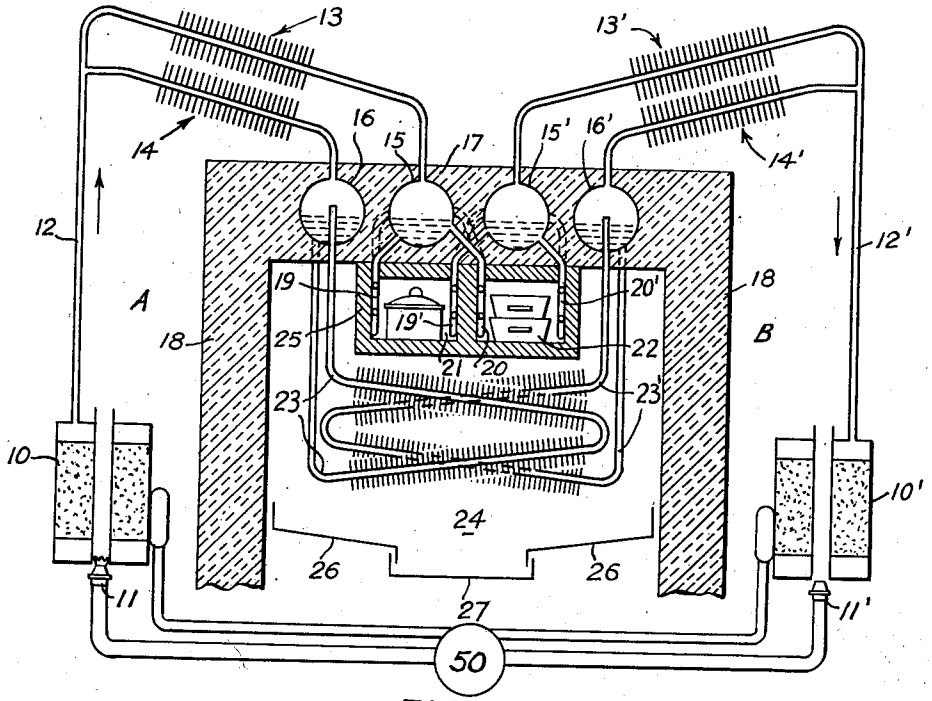


FIG. 1.

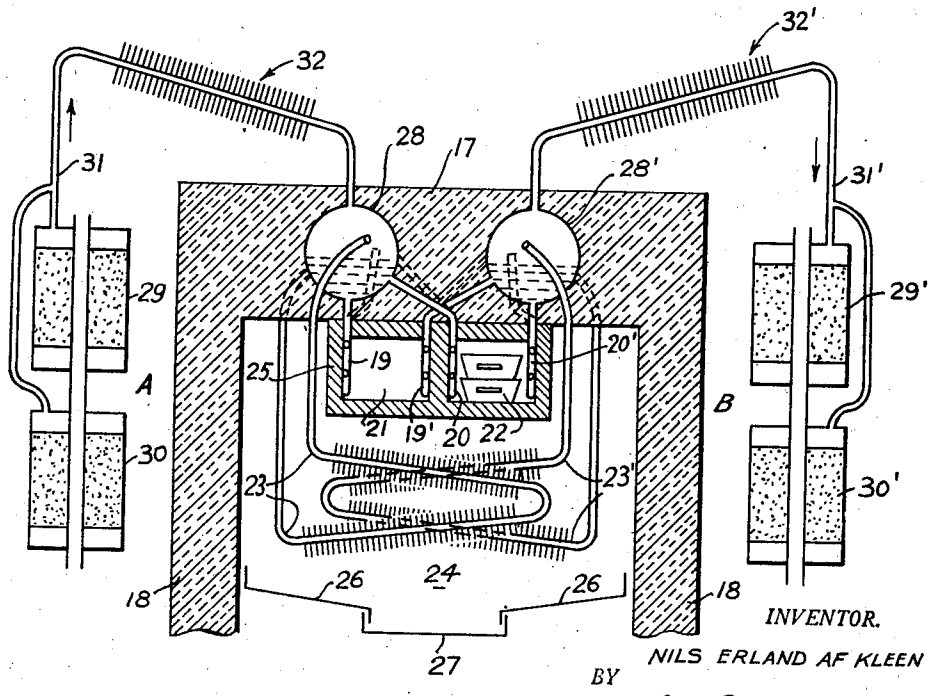


FIG. 4.

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FIG. 3.

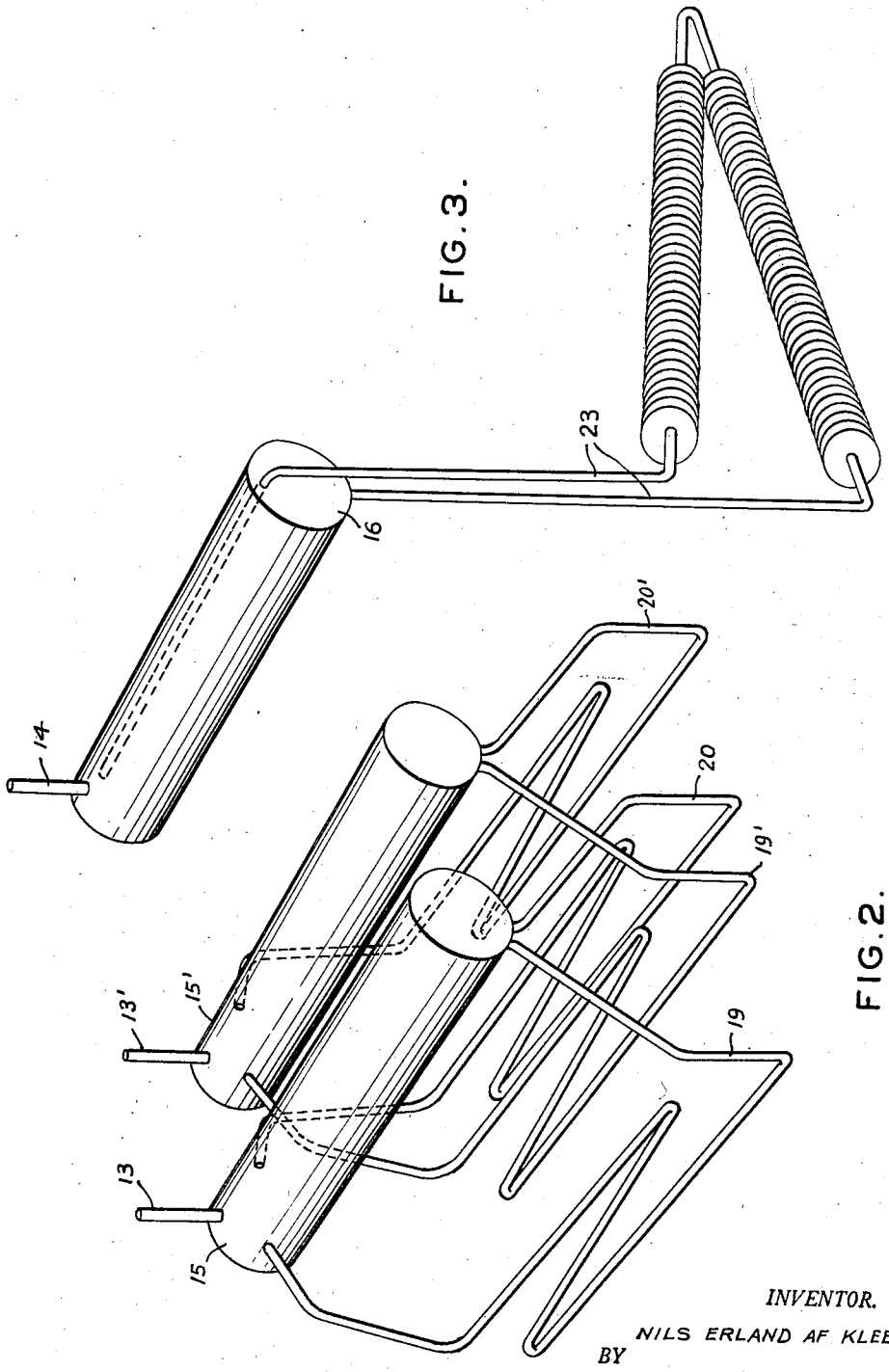


FIG. 2.

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UNITED STATES PATENT OFFICE

2,353,715

ABSORPTION REFRIGERATING APPARATUS

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Application February 17, 1942, Serial No. 431,208

10 Claims. (Cl. 62—118)

This invention relates to new and useful improvements in refrigeration and is a continuation in part of my co-pending application, Ser. No. 370,431, filed December 17, 1940.

The present invention is directed more particularly to absorption refrigerating apparatus and has for its primary object to produce refrigeration simultaneously at a plurality of different points such, for example, as the different temperature compartments in a refrigerator cabinet, by means of separate refrigerant evaporating elements.

To this end, one embodiment of the invention consists in the provision of a plurality of cooling means for respectively different compartments of a refrigeration cabinet or the like, which compartments include an ice-freezing compartment, a low temperature storage compartment and a higher temperature storage compartment, in which each cooling means comprises two cooling sections having alternate cooling and inactive periods and operating in out-of-phase relation to each other to provide a continuous cooling effect in said ice-freezing, low temperature and higher temperature storage compartments and in which the cooling sections of the cooling means for the higher temperature storage compartment are alternately coated with frost and defrosted in out-of-phase relation to each other to maintain a relatively high humidity in said last named compartment.

The new and novel features of the invention will become apparent from the following description taken in conjunction with the accompanying drawings, and the invention will be more particularly pointed out in the appended claims.

Referring to the drawings, in which numerals of like character designate similar parts throughout the several views,

Fig. 1 is a diagrammatic view of absorption refrigerating apparatus embodying a plurality of cooling means in accordance with the present invention for producing refrigeration simultaneously in the different compartments of a refrigerator cabinet shown in section and broken away;

Fig. 2 is a detail perspective view of the evaporating circuits for the low temperature compartments of the cabinet;

Fig. 3 is a similar view of one of the refrigerant evaporating circuits for the main storage compartment of the cabinet; and

Fig. 4 is a diagrammatic view similar to Fig. 1, but showing a modification.

In the drawings, referring more particularly to Fig. 1, the refrigerating apparatus illustrated as an example, is of the intermittent absorption type and comprises two units generally indicated as A and B, respectively, operating in out-of-phase relation to each other to produce substantially continuous refrigeration. Inasmuch as the units are similar in all respects to one another, only the parts of unit A will be described in detail, the corresponding parts of unit B being distinguished by the prime of the numerals used in describing unit A.

Each unit includes a boiler-absorber 10 containing absorbent material and adapted to be heated during the generating periods by any suitable means such for example as the gas burner 11. The refrigerant vapors liberated from the absorbent during the generating periods pass upwardly through vapor conduit 12 leading to a pair of condensers 13 and 14 where the refrigerant is liquefied and delivered to separate collecting tanks 15 and 16 arranged in the insulated top wall 17 of the refrigerator cabinet 18. Associated with the collecting vessel 15 is a pair of cooling coils or evaporators 19 and 20, the former, 19, arranged in one side of a low temperature or freezing compartment 21, and the other cooling coil 20 similarly arranged in another low temperature compartment such as the ice-tray compartment 22. As clearly shown in Fig. 2, one end of each of the cooling coils or evaporators 19 and 20 is connected to the bottom of the vessel 15 and the other end of each of these coils terminates in communication with the upper portion of the vessel. From the collecting vessel 16, a finned cooling coil 23 extends downwardly at one end from the bottom of the vessel into the main storage compartment 24 of the cabinet 18 and terminates at its opposite end in communication with the upper portion of the vessel 16, as clearly shown in Fig. 3.

Thus, one end of the evaporator coil 23, is in liquid communication with the vessel 16 and the other end is in vapor communication therewith. The vessel 16 is functionally a part of the conduit 12 which is connected with the refrigerant passage opening 12a of the boiler-absorber 10, which is a closed vessel having the absorbent therein to absorb the refrigerant fluid when acting as an absorber, and to deliver the refrigerant fluid therefrom when acting as a generator.

The collecting vessel 15 is also supplied by a part of the conduit 12 and has depending therefrom two coils or evaporators 19 and 20, which like evaporator 23, have each one end for liquid communication therewith and the other end for vapor communication therewith. Collecting ves-

sel 15' has two depending evaporators 19' and 20', like those described and marked 19 and 20. Collecting vessel 16' has the depending evaporator 23' like evaporator 23.

The evaporators 23 and 23', the evaporators 19 and 19', and the evaporators 20 and 21', are arranged in pairs, with the evaporators of each pair operative in out of phase relation to each other. A wall 25 separates the respective pairs, as for instance evaporators 23 ano 23' are separated by wall 25 from evaporators 19 and 19', and also from evaporators 20 and 20', and in turn evaporators 19 and 19' are separated from evaporators 20 and 20'.

For the absorption periods of the unit, the burner 11 is turned off and the refrigerant evaporating in the cooling coils 19, 20 and 23 returns to the boiler-absorber 10 to be reabsorbed by the absorbent, following which the burner is again turned on to repeat the cycle just described.

The operation of each of the units A and B from generating to absorbing and vice versa is controlled by the usual thermostat mechanism shown diagrammatically at 50 and operating to permit the flow of fuel to one and prevent the flow of fuel to the other of the burners 11 and 11' and vice versa so that when one unit, for example unit A, is generating, unit B is absorbing. Thus, during the operation of the refrigerating apparatus, when unit A is generating, relatively warm liquid refrigerant will be supplied to the cooling coils, while the refrigerant in cooling coils 19', 20' and 23' of unit B which is absorbing will evaporate to produce refrigeration, and when unit A is absorbing, the refrigerant in the cooling coils or evaporators 19, 20 and 23 will evaporate to produce refrigeration, while relatively warm liquid refrigerant will be supplied to the cooling coils 19', 20' and 23'. Each of the compartments 21, 22 and 24 is therefore cooled by a separate pair of cooling coils producing intermittent cold in out-of-phase relation to each other so that substantially continuous refrigeration is produced in each compartment.

In the low temperature compartments 21 and 22, the cooling coils or evaporators 19 and 20 of one unit are thermally connected to the corresponding coils 19' and 20' of the other unit by means of the heat-conducting walls 25 of the compartments, which walls are shown relatively thick to accumulate the cold produced intermittently by each of the cooling coils so that a substantially unchanged low temperature will be maintained in each of the low temperature compartments. However, in the main storage compartment 24, due to the fact that the cooling coils 23 and 23' are separate from one another in a heat-conducting respect, each will alternately be coated with frost and be defrosted during the absorbing and generating periods, respectively, of the respective unit, so that a relatively high humidity will be maintained in this compartment of the cabinet 18. The condensate formed on the coils 23 and 23' during the intermittent defrosting thereof will fall onto plates 26 and be collected in a drip pan or tray 27 which may be removed and emptied whenever necessary.

While I have shown and described the cooling coils or evaporators 19 and 20 of one unit connected to a common collecting vessel 15 and the corresponding cooling coils 19' and 20' of the other unit connected to vessel 15', each of these cooling coils may be connected to separate collecting vessels, the vessels for one set of cooling coils being supplied with liquid refrigerant in out-of-phase relation to the collecting vessels for the other set of cooling coils. Moreover, as shown in Fig. 4, each of the cooling coils 19, 20 and 23 of one unit may be connected to a common vessel 28 and the corresponding cooling coils 19', 20' and 23' of the other unit similarly connected to a common vessel 28'.

The refrigerant for each of the collecting vessels may be generated substantially continuously from a common generating source and the flow of the refrigerant diverted alternately into one and the other of two separate collecting vessels or two separate sets of collecting vessels, or, as shown in Fig. 4, the collecting vessels 28 and 28' may form parts of separate intermittent absorption units A and B, respectively. Furthermore, as also shown in Fig. 4, each of the units A and B may include two or more boiler-absorbers 29, 30 and 29', 30', respectively. The boiler-absorbers of unit A are connected in series or tandem relation with each other and the refrigerant generated therein passes by way of vapor conduit 31 to a condenser 32 and is delivered as condensate to the vessel 28 during the generating periods. A similar tandem arrangement of the boiler-absorbers 29' and 30' is provided for unit B in fluid communication with the vessel 28' by way of conduit 31' and condenser 32'.

It will thus be seen that I have provided refrigerating apparatus embodying a plurality of cooling means for producing refrigeration simultaneously in a plurality of different zones or compartments, that each of the cooling means consists of at least two separate cooling sections each producing a cooling effect intermittently but in out-of-phase relation to each other, that for the low temperature zones or compartments, the separate cooling sections of the corresponding cooling means are thermally connected together by heat conducting means which accumulate the cold produced intermittently by each of the so connected cooling sections so that a substantially unchanged low temperature is maintained thereby, and that in the higher temperature compartment or compartments, the separate cooling sections are separate from one another in a heat conducting relation so that each is alternately coated with frost and defrosted during the cold producing periods and the inactive periods thereof, respectively, to maintain a relatively high humidity in the latter compartment or compartments.

From the foregoing it is believed that the construction, operation and advantages of my invention may be readily understood by those skilled in the art without further description, it being borne in mind that numerous changes may be made in the details disclosed without departing from the spirit of the invention as set out in the following claims.

What I claim is:

1. In a refrigerator, the combination with a plurality of compartments to be cooled including an ice-freezing compartment, a low temperature storage compartment, and a higher temperature storage compartment; of a plurality of cooling parts having alternate cooling and inactive periods and arranged in pairs including one pair for said ice-freezing compartment, a second pair for said low temperature storage compartment and a third pair for said higher temperature storage compartment with the alternate cooling and inactive periods of one of the cooling parts of each of said pairs being in out-of-phase relation to the corresponding periods of the other one of the cooling parts of each of said pairs to

provide substantially continuous cooling and with the cooling parts of the third pair arranged in indirect thermal transfer relation to one another to cool the air in said higher temperature storage compartment so that each of said last named cooling parts becomes alternately coated with frost and defrosted during its cooling and inactive periods, respectively, to provide a relatively high humidity in said higher temperature storage compartment.

2. In a refrigerator, the combination with a plurality of compartments to be cooled including an ice-freezing compartment, a low temperature storage compartment, and a higher temperature main storage compartment; of refrigerating apparatus including a plurality of evaporator parts arranged in pairs including one pair for said ice-freezing compartment, a second pair for said low temperature storage compartment and a third pair for said higher temperature main storage compartment with the evaporator parts of said third named pair arranged in indirect thermal transfer relation to one another for air cooling, means for alternately supplying refrigerant liquid to and withdrawing refrigerant vapor from one of the evaporator parts of each of said pairs, and means for alternately supplying refrigerant liquid to and withdrawing refrigerant vapor from the other one of the evaporator parts of each of said pairs in out-of-phase relation to the first named evaporator parts of said pairs to provide substantially continuous refrigeration for each of said compartments with alternate frosting and defrosting of each of the evaporator parts of said third named pair in out-of-phase relationship with respect to one another to provide a relatively high humidity in said higher temperature main storage compartment.

3. In a refrigerator, the combination with a plurality of compartments to be cooled including an ice-freezing compartment, a low temperature storage compartment, and a higher temperature main storage compartment; of means including a plurality of cooling parts having alternate cooling and inactive periods and comprising one for said ice-freezing compartment, another for said low temperature storage compartment, and a third for said higher temperature main storage compartment; and separate means including a plurality of cooling parts having alternate cooling and inactive periods in out-of-phase relation to said first named cooling parts and comprising one for said ice-freezing compartment, another for said low temperature storage compartment and a third for said higher temperature main storage compartment, the cooling parts for said higher temperature main storage compartment of each of said first named and second named means being arranged in indirect thermal transfer relation to one another for air cooling so that each becomes alternately coated with frost and defrosted during its cooling and inactive periods, respectively, to provide a relatively high humidity in said higher temperature main storage compartment.

4. In a refrigerator, the combination with a plurality of compartments to be cooled including an ice-freezing compartment, a low temperature storage compartment, and a higher temperature main storage compartment; means comprising a plurality of cooling parts arranged in pairs including one pair for said ice-freezing compartment with the cooling parts arranged in direct thermal transfer relation to one another, a second pair for said low temperature storage compartment, and a third pair for said higher temperature main storage compartment, with the cooling parts of said third pair arranged in indirect thermal transfer relation to one another for air cooling; of means for alternately supplying a heat transferring fluid to and withdrawing such fluid from one of the cooling parts of each of said pairs; and means for alternately supplying a heat transferring fluid to and withdrawing such fluid from the other one of the cooling parts of each of said pairs in out-of-phase relation to the first named cooling parts of said pairs to provide substantially continuous cooling for each of said compartments with alternate frosting and defrosting of each of the cooling parts of said third named pair in out-of-phase relationship with respect to one another to provide a relatively high humidity in said higher temperature main storage compartment.

5. In a refrigerator, the combination with a plurality of compartments to be cooled including an ice-freezing compartment, a low temperature storage compartment, and a higher temperature storage compartment; of means comprising a plurality of receptacles supplied with refrigerant liquid intermittently, one half supplied with refrigerant liquid in out-of-phase relation to the other half, and a plurality of cooling coils divided into groups, including one group connected for the gravity flow of refrigerant from one half of said receptacles and comprising a cooling coil for said ice-freezing compartment, a second cooling coil for said low temperature storage compartment and a third cooling coil for said higher temperature storage compartment, and another group connected for the gravity flow of refrigerant from the other half of said receptacles and comprising a cooling coil for said ice-freezing compartment, a second cooling coil for said low temperature storage compartment and a third cooling coil for said higher temperature storage compartment, whereby substantially continuous cooling is provided for each of said compartments, the third named cooling coil associated with one group being arranged in indirect thermal transfer relation to the corresponding cooling coil associated with the other group to cool the air in said higher temperature storage compartment so that each of said last named cooling coils becomes alternately coated with frost and defrosted, one in out-of-phase relation to the other.

6. In a refrigerator, the combination with a plurality of compartments to be cooled including an ice-freezing compartment, a low temperature storage compartment, and a higher temperature storage compartment; of means comprising a plurality of receptacles including one supplied with refrigerant liquid intermittently and another one supplied with refrigerant liquid intermittently and in out-of-phase relation to the first one, and a plurality of cooling coils divided into two groups one group connected for the gravity flow of refrigerant from the first one of said receptacles and including a cooling coil for said ice-freezing compartment, a second cooling coil for said low temperature storage compartment, and a third cooling coil for said higher temperature storage compartment, and the other group connected for the gravity flow of refrigerant from the second one of said receptacles and including a cooling coil for said ice-freezing compartment, a second cooling coil for said low temperature storage compartment, and a third cooling coil for said higher temperature storage compartment, whereby substantially continuous cooling is provided

for each of said compartments, the third named cooling coil associated with one group being arranged in indirect thermal transfer relation to the corresponding cooling coil associated with the other group to cool the air in said higher temperature storage compartment so that each of said last named cooling coils becomes alternately coated with frost and defrosted, one in out-of-phase relation to the other.

7. In a refrigerator, the combination with a plurality of compartments to be cooled including an ice-freezing compartment, a low temperature storage compartment, and a higher temperature storage compartment; of means comprising a plurality of receptacles including two supplied with refrigerant liquid intermittently and two others supplied with refrigerant liquid intermittently and in out-of-phase relation to the first two, and a plurality of cooling coils divided into two groups, each group including a cooling coil for said ice-freezing compartment, a second cooling coil for said low temperature compartment, and a third cooling coil for said higher temperature storage compartment, two of the three-named cooling coils of the first group being in fluid communication with one and the other one of the three-named cooling coils of said first group being in fluid communication with the other one of the first named receptacles, and two of the three-named cooling coils of the second group being in fluid communication with one and the other one of the three-named cooling coils of said second group being in fluid communication with the other one of the second named receptacles, whereby substantially continuous cooling is provided for each of said compartments, the third named cooling coil associated with one group being arranged in indirect thermal transfer relation to the corresponding cooling coil associated with the other group to cool the air in said higher temperature storage compartment so that each of said last named cooling coils becomes alternately coated with frost and defrosted one in out-of-phase relation to the other.

8. In a refrigerator, the combination with a plurality of compartments to be cooled including an ice-freezing compartment, a low temperature storage compartment, and a higher temperature storage compartment; of means comprising a plurality of receptacles including two supplied with refrigerant liquid intermittently and two others supplied with refrigerant liquid intermittently and in out-of-phase relation to the first two, and a plurality of cooling coils divided into two groups, each group including a cooling coil for said ice-freezing compartment, a second cooling coil for said low temperature storage compartment, and a third cooling coil for said higher temperature storage compartment, the first and second cooling coils of one group being in fluid communication with one and the third cooling coil of the said one group being in fluid communication with the other one of said first named receptacles, and the first and second cooling coils of the other group being in fluid communication with one and the third cooling coil of said other group being in fluid communication with the other one of said second named receptacles, whereby substantially continuous cooling is provided for each of said compartments, the third cooling coil associated with one group being arranged in indirect thermal transfer relation with the corresponding cooling coil associated with the other group to cool the air in said higher temperature storage compartment so that each of said last named cooling coils becomes alternately coated with frost and defrosted one in out-of-phase relation to the other.

9. In a refrigerator; the combination of means arranged to provide a plurality of compartments including an ice-freezing compartment, a low temperature storage compartment and a higher temperature storage compartment; and refrigerating apparatus of the intermittent absorption type including two units having alternate generating and absorbing periods and operating in out-of-phase relation to one another to provide substantially continuous refrigeration with each unit having a plurality of refrigerant evaporating elements connected for the flow of the refrigeration fluid and including one for said ice-freezing compartment, a second for said low temperature storage compartment, and a third for said higher temperature storage compartment and with the third named evaporating element of one unit arranged in indirect thermal transfer relation to the corresponding evaporating element of the other unit and adapted to cool the air in said higher temperature storage compartment so that each of said third named evaporating elements becomes alternately coated with frost and defrosted during the absorbing and generating periods, respectively, of the associated unit to provide a relatively high humidity in said higher temperature storage compartment.

10. In a refrigerator of the intermittent absorption type, the combination with a plurality of boiler-absorbers each operative during alternate periods as an absorber for refrigerant fluid and as a deliverer of the same, means operating one of said boiler-absorbers alternately as an absorber and as a generator and another one of said boiler-absorbers alternately as an absorber and as a generator in out-of-phase relation to the first boiler-absorber, each of said first and second boiler-absorbers having a plurality of evaporator parts in fluid communication therewith to form at least three pairs of evaporator parts in each of which pairs one of the evaporator parts operates in out-of-phase relation with the other evaporator part of said pair; of a wall between each of said pairs of evaporator parts, and a thermal connection between the evaporator parts of each of at least two of said pairs, the third pair of evaporator parts being thermally unconnected.

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