Feb. 19, 1952 S. M. BÄCKSTRÖM 2,585,908

MULTIPLE TEMPERATURE REFRIGERATION SYSTEM

Filed Dec. 15, 1945 2 SHEETS—SHEET 1

Fig. 1.

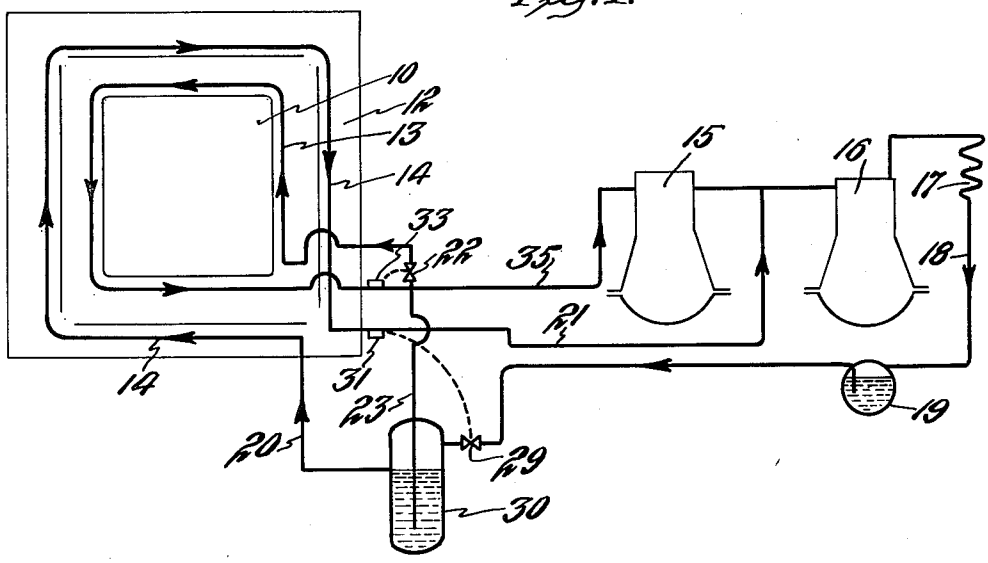
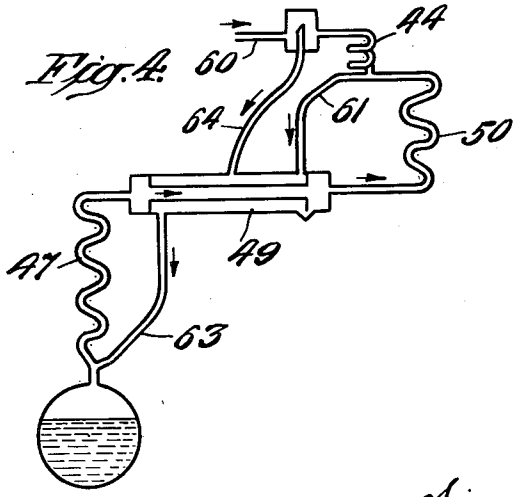


Fig. 4.



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Fig. 2.

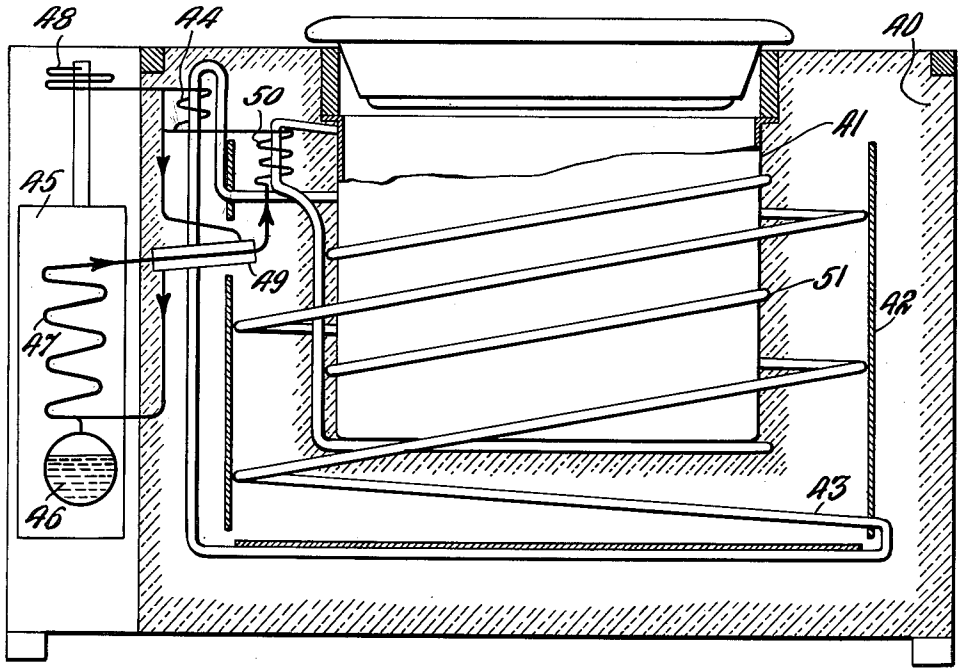
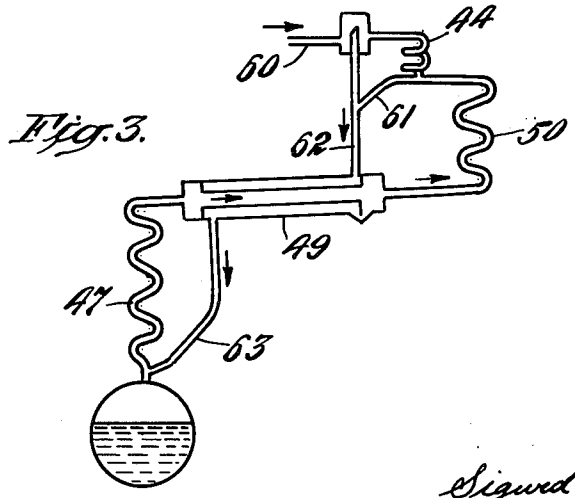


Fig. 3.



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MULTIPLE TEMPERATURE REFRIGERATION SYSTEM

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6 Claims. (Cl. 62—95)

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This invention relates to refrigeration, and more particularly to a method of and apparatus for producing low temperatures for refrigeration purposes with the aid of two cooling evaporators or cooling elements adapted to operate at different temperatures.

It is an object of the invention to simplify the construction of refrigeration apparatus for producing such relatively low temperatures, and further to improve working conditions under which the apparatus operates.

It has been previously proposed to employ evaporators adapted to operate at different temperatures in compression type refrigeration apparatus. However, it has been necessary to employ multi-stage compressors having two stages of different dimensions, each of which is associated with a particular evaporator. Further in absorption refrigerating apparatus of the inert gas type it is known to effect evaporation of refrigerant in inert gas having different partial vapor pressure of refrigerant fluid whereby such evaporation takes place at different temperatures. In cooling compartments and refrigerated boxes operating at a generally very low, relatively constant temperature there is practically only one temperature cold requirement. Accordingly, it would be difficult and uneconomical to provide such apparatus with two or more evaporators operating at different temperatures for producing refrigeration where substantially one low temperature is required. There is, however, also needed a certain additional quantity of cold besides the quantity of cold needed for cooling the box itself, namely, a cooling effect which approximately equalizes the difference between the condensing temperature and the evaporating temperature of the refrigerant. If the refrigeration apparatus is provided with a high temperature evaporator for this special purpose, the cooling effect is obviously correspondingly increased in the low temperature evaporator. This arrangement has been utilized both in cooling machines having a two-stage compressor with throttling of the two stages and sometimes also in absorption machines, but, since the requirement of cold at the higher temperature generally is very small, scarcely any considerable advantage is obtained by this arrangement. The invention takes this condition into consideration and is essentially characterized thereby that the heat flow passing through the heat insulation surrounding the refrigerator storage compartment is absorbed in part by the higher temperature cooling element which is disposed in the path of the heat flow to the low temperature cooling element.

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The invention will be hereinafter more fully described with reference to several embodiments for carrying out the invention diagrammatically shown in the accompanying drawings and in this connection further characteristic features of the invention will be set forth.

Fig. 1 diagrammatically shows a refrigerating compressor-equipment having a two-stage compressor or two compressors respectively. Fig. 2 shows also diagrammatically an arrangement employing an absorption refrigerating apparatus of the inert gas type. Figs. 3 and 4 diagrammatically show suitable connections for the inert gas circuit of the absorption refrigerating apparatus illustrated in Fig. 2.

In Fig. 1 reference numeral 10 denotes a cooling compartment for example in a refrigerator cabinet, 12 denotes the heat insulation surrounding the cooling compartment which in this case is especially thick. The compartment 10, which for example may consist of a liner stamped from sheet metal in one integral piece is arranged to be cooled by a low temperature evaporator which is wound in the form of a pipe coil 13 around the liner in heat conductive relation therewith. Inside the insulation a second evaporator coil 14 is arranged which is adapted to operate at an essentially higher temperature than the evaporator 13. The refrigeration apparatus comprises a low pressure compressor 15 and a high pressure compressor 16 arranged to operate in series and to supply vapour at high pressure to the condensor 17 of the apparatus in which the vapour is condensed and from which condensate is conveyed to the receiver 19 of the apparatus through a conduit 18. From the receiver 19 refrigerant passes through a high pressure expansion valve 29, a liquid container 30 and conduit 20 to the high temperature evaporator 14. From the evaporator 14 the vapour is withdrawn through a conduit 21 back to the high pressure compressor 16. Refrigerant is supplied to the low temperature evaporator 13 through low temperature expansion valve 22 which is connected in a conduit 23 which extends into the lower part of the liquid container 30. The distribution of refrigerant between the two evaporators 13 and 14 takes place through the intermediary of thermostatically operated expansion valves 29 and 22, the sensible control bulbs of which are denoted by 31 and 33 respectively. These valves automatically control flow of refrigerant in such manner that approximately the same degree of superheating will take place in the conduits 21 and 35 respectively.

It has been mentioned that the low tempera-

ture evaporator 13 is arranged in heat conductive relation with the metal lining of the cooling compartment, such lining thus forming a heat transfer member. In an analogous manner the high temperature evaporator 14 may also be welded to metal plates forming an inner layer of the insulation. By way of example a suitable operating temperature of −60° C. in the evaporator 13 may be mentioned. Between the two evaporators and outside the evaporator 14 heat insulating layers are provided, the insulating value of which obviously must be chosen with regard to the temperature of the surroundings and the difference in temperature between the two evaporators.

It is evident that the vapour pressure of the refrigerant in the low temperature evaporator must be essentially lower than the vapour pressure of the refrigerant in the high temperature evaporator. The stroke volume of the low pressure compressor should, therefore, be many times greater than the stroke volume of the high pressure compressor. By arranging the low pressure compressor in accord with the invention, the load for the two evaporators 13 and 14 may be adjusted in such manner that the same stroke volume may be considered for both compressors. They may therefore be the same which from the point of view of manufacture, is particularly advantageous and also means a simplification of the construction of the compressor.

Also in refrigerator cabinets and refrigerators operated by absorption refrigerating apparatus of the inert gas type similar conditions prevail, since the partial pressure of the refrigerant in the inert gas at low temperatures is extraordinarily small wherefore the quantity of gas required for vapourising for example 1 kg. ammonia will be considerable. Such an intensive gas circulation is uneconomical at the higher temperature prevailing in the high temperature evaporator. In Fig. 2 an embodiment of the invention is shown in which a refrigerator cabinet is cooled by an absorption refrigerating apparatus of the inert gas type. It will be assumed that the apparatus operates with water, ammonia and hydrogen gas. In Fig. 2 reference numeral 40 denotes the insulating layer of the refrigerator cabinet and 41 the inner lining of the cooling compartment preferably pressed from metal plates. Metal plates 42 are inserted in the insulation in heat conductive relation with a secondary heat transfer system 43 which transfers heat to the high temperature evaporator 44 of the absorption refrigerating apparatus. The absorption refrigerating apparatus is denoted by 45 and very diagrammatically shown. In the apparatus reference numeral 46 thus denotes its absorber vessel, 47 its absorber, 48 its condenser and 49 its gas heat exchanger. The inert gas circuit includes the absorber 47, gas heat exchanger 49, high temperature evaporator 44 and a low temperature evaporator 50. The low temperature evaporator absorbs heat from a secondary heat transfer system 51 which is heat conductively connected to the inner lining 41 of the cooling compartment. The two secondary heat transfer systems 43 and 51 may be of a well known kind and of the vaporization-condensation type, for example. It may be assumed that the temperature of a cooling compartment is to be maintained at about −25° C. and that the temperature of the plates 42 is to be maintained at about −10° C. It is evident that, under these conditions, the quantity of heat which must be transferred from the cooling compartment to the low temperature evaporator 50 will be materially less than in an arrangement in which the refrigeration of the insulation by the heat transfer system 43 is not employed.

According to the invention it is very advantageous to provide an inert gas circuit in which extremely intensive gas circulation through the high temperature evaporator 44 is avoided. Fig. 3 diagrammatically shows the manner in which the parts of the inert gas circuit preferably should be connected. The numerals correspond to those of Fig. 2. As appears from the arrows in Fig. 3 liquid refrigerant flowing in a conduit 60 passes through the high temperature evaporator 44 and thereafter through the low temperature evaporator 50. On the other hand the gas flows from the absorber 47 through the gas heat exchanger 49, the low temperature evaporator 50 and thereafter partly through the high temperature evaporator 44, partly through the conduits 61 and 62, the heat exchanger 49 and a conduit 63 back to the absorber. The gas flowing through the high temperature evaporator 44 passes through the conduit 62, the exchanger 49 and the conduit 63 likewise back to the absorber. The diverted inert gas flowing into conduit 61 thus by-passes the high temperature evaporator, thereby avoiding an extremely intensive circulation of inert gas therethrough. It may be desirable in certain instances to provide an inert gas circuit in which the parts thereof are connected according to Fig. 4, which diagrammatically shows a modification of Fig. 3 in which the reference numerals mutually correspond except that of conduit 62 which in Fig. 4 is represented by a separate conduit 64. This conduit connects through the condenser 60 of the apparatus, the high temperature evaporator 44 and a point in the gas heat exchanger 49 at which the temperature of the gas therein corresponds to that of the gas passing through the conduit 64 upon entering the exchanger. The conduit 61, in which the colder gas passes, is, as in Fig. 3, connected with the end point of the exchanger.

Reference is made to applicant's divisional application Serial No. 221,575, filed April 18, 1951, which claims features of the inert gas circuit of the absorption refrigeration apparatus disclosed in Figs. 2, 3 and 4.

The invention is not to be limited to the embodiments shown and described but may be varied in several mays within the scope of the basic inventive idea.

I claim:

1. In a refrigerator comprising a cabinet having an inner liner defining a storage compartment and a body of insulating material disposed about such liner, refrigeration apparatus including a low temperature cooling element and a higher temperature cooling element, a first system for heat transfer fluid having a heat rejecting portion in heat conductive relation with said low temperature cooling element and a heat abstracting portion in heat conductive relation with air in the compartment, and a second system for heat transfer fluid having a heat rejecting portion in heat conductive relation with said higher temperature cooling element and a heat abstracting portion having a major portion thereof disposed about said liner and located in the insulating body at a region which is spaced from the inner and outer surfaces thereof.

2. In a refrigerator comprising a cabinet hav-

ing an inner liner defining a storage compartment and a body of insulating material snugly disposed about such liner, refrigeration apparatus including a low temperature cooling element and a higher temperature cooling element, a first system for heat transfer fluid having a heat rejecting portion in heat conductive relation with said low temperature cooling element and a heat abstracting portion in the form of a coil which is in heat conductive connection with the exterior surface of said liner, and a second system for heat transfer fluid having a heat rejecting portion in heat conductive relation with said higher temperature cooling element and a heat abstracting portion in the form of a coil having a major portion thereof disposed about said liner and located in the insulating body at a region which is spaced from the inner and outer surfaces thereof.

3. In a refrigerator comprising a cabinet having an inner liner defining a storage compartment and a body of insulating material disposed about such liner, an absorption type refrigeration system having first and second cooling elements in which refrigerant fluid evaporates in the presence of an inert gas, the refrigerant fluid evaporating into inert gas at a low temperature in said first cooling element and at a higher temperature in said second cooling element, a first system for heat transfer fluid having a heat rejecting portion in heat conductive relation with said first cooling element and a heat abstracting portion arranged to abstract heat from the compartment, a second system for heat transfer fluid having a heat rejecting portion in heat conductive relation with said second cooling element and a heat abstracting portion, and means for retarding heat transfer inwardly through said insulating body to a major portion of the area of said liner including said last-mentioned heat abstracting portion.

4. In a refrigerator comprising a cabinet having an inner liner whose inner surface defines a storage compartment having a top access opening adapted to be closed by a thermally insulated closure member and a body of insulating material enveloping said liner, a first evaporator comprising a coil of extended length disposed about a major portion of the peripheral side wall of said liner and heat conductively connected to the exterior or outer surface thereof, a second evaporator comprising a coil of extended length disposed about and surrounding said first-mentioned coil and heat conductively related to said insulating body at a region which is between and removed both from said liner and the exterior surface of said insulating body, and means including an absorption refrigeration system employing evaporation of refrigerant in the presence of inert gas for rendering said first evaporator operable to enable frozen food packages and the like to be stored in said compartment and for maintaining said second evaporator at a temperature which

is at a higher value than that of said first evaporator and at a lower value than that of ambient air.

5. In a refrigerator comprising a cabinet having an inner liner defining a storage compartment and a body of insulating material disposed about such liner, refrigeration apparatus including a low temperature cooling element and a higher temperature cooling element, a first system for heat transfer fluid having a heat rejecting portion in heat conductive relation with said low temperature cooling element and a heat abstracting portion in heat conductive relation with air in the compartment, a second system for heat transfer fluid having a heat rejecting portion in heat conductive relation with said higher temperature cooling element and a heat abstracting portion, and means for retarding heat transfer from the exterior of the cabinet through said insulating body to a major portion of the area of said liner including the heat abstracting portion of said second system which is disposed in said insulating body and spaced from the inner and outer surfaces thereof.

6. In a refrigerator comprising a cabinet having an inner liner defining a storage compartment and a body of insulating material snugly disposed about such liner, refrigeration apparatus including a low temperature cooling element and a higher temperature cooling element, a first system for heat transfer fluid having a heat rejecting portion in heat conductive relation with said low temperature cooling element and a heat abstracting portion in the form of a coil which is in heat conductive relation with the exterior surface of said liner, a second system for heat transfer fluid having a heat rejecting portion in heat conductive relation with said higher temperature cooling element and a heat abstracting portion in the form of a coil, and means for retarding heat transfer from the exterior of the cabinet through said insulating body to a major portion of the area of said liner including the heat abstracting portion of said second system which is disposed in said insulating body and spaced from the inner and outer surfaces thereof.

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