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REFRIGERATION APPARATUS

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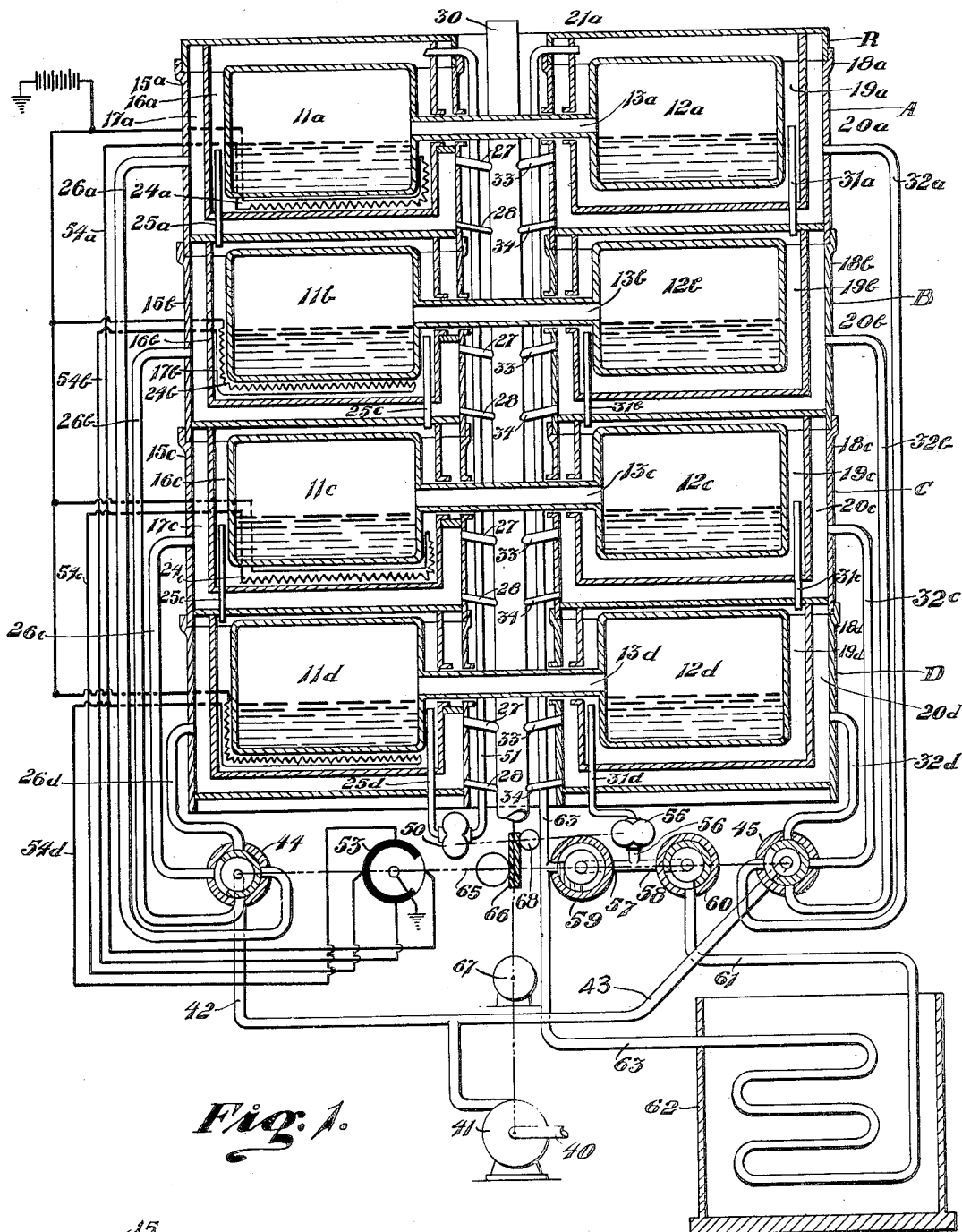


Fig. 1.

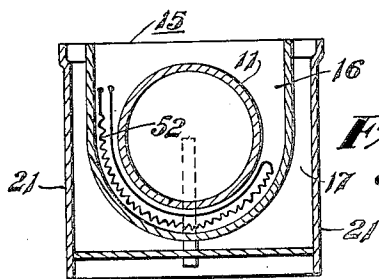


Fig. 2.

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REFRIGERATION APPARATUS.

Application filed December 12, 1921. Serial No. 521,871.

To all whom it may concern:

Be it known that I, ALEXANDER T. KASLEY, a citizen of the United States, and a resident of Essington, in the county of Delaware and State of Pennsylvania, have invented a new and useful Improvement in Refrigeration Apparatus, of which the following is a specification.

This invention relates to the art of refrigeration and has particular reference to an evaporation-absorption process of refrigeration. It has for an object the provision of an improved method and apparatus for carrying out a process of the character designated which shall be entirely automatic and continuous in operation and which shall develop low refrigerating temperatures with but a relatively small expenditure of energy. It has for a further object the elimination, in an apparatus of the character designated, of any possibility of escape of obnoxious fumes from the refrigerant. A still further object is to provide a sectional construction for a refrigeration apparatus of the character designated in which the sections shall be identical in structure and hence interchangeable and readily replaceable.

These and other objects of my invention, which will be more manifest throughout the further description of my invention, are attained by means of the apparatus described herein and illustrated in the accompanying drawing in which Fig. 1 is a diagrammatic sectional view of a device constructed in accordance with my invention, and Fig. 2 is a transverse sectional view through one of the refrigerating units.

In the drawing, I indicate a plurality of refrigerating sections identical in construction and superimposed one over the other. As shown, the apparatus is composed of four sections, A, B, C, D, the upper section A being provided with a suitable cover R. The like elements of the several sections have been designated by like reference numerals followed respectively by the letters *a, b, c, or d*, corresponding to the sections A, B, C, or D, with which the parts so designated are associated. A detailed description of one section, therefore, will, for the purposes of this specification, serve for all.

A section of the structure illustrated is in

itself a complete refrigeration unit and, as shown, is composed of a dumb-bell having two enlarged chambers, a still-absorber 11 and an evaporator-absorber 12, connected by a conduit 13. The conduit 13 is horizontally disposed when in operative position and communicates with the chambers 11, 12 at a central point. The dumb-bells contain suitable refrigerating fluids, as, for example, ammonia as a refrigerant and water as an absorbent, the level of the liquid in the dumb-bell being slightly below the level of the conduit 13, so that excess liquid in either chamber may be drained through the conduit to the other chamber without materially restricting the passage of vapors through the conduit. Air should be preferably exhausted from the dumb-bell since the evaporation and absorption of the ammonia takes place more readily when no air is present. The dumb-bell should, moreover, be hermetically sealed in order to prevent an escape of the ammonia vapors.

The still-absorber 11 is disposed within a receptacle 15, having an inner compartment 16 spaced from and substantially surrounding the still-absorber 11, and an outer compartment 17. The evaporator-absorber is similarly situated in a receptacle 18, having an inner compartment 19 and an outer compartment 20. The receptacles 15 and 18 are integrally secured one to the other, as by common side walls 21.

The inner compartment 16 of the still-absorber contains a heater 24 of suitable construction, as shown, an electric heater, and is approximately half-filled with a heat conveying medium, such as oil, the level of the medium being maintained constant by means of an over-flow pipe 25, which drains into the compartment 16 of the section below. The outer compartment 17 is adapted to accommodate a circulating cooling fluid, such as water, and is provided with a cooling fluid inlet pipe 26, a level-controlling over-flow pipe 27 of relatively large capacity, and a drain pipe 28 of limited capacity leading from the bottom of the compartment 17. Both pipes 27 and 28 lead to a waste main 30, which may empty into any suitable discharge means.

The inner compartment 19 of the evaporator-absorber is adapted to contain a refrigerating fluid, such as a salt solution, the

level of the brine being regulated by means of an over-flow pipe 31, which drains into the compartment 19 of the section below. The outer compartment 20 is arranged for the circulation of a cooling fluid there-
 5 through, and is provided with an inlet pipe 32, a level-controlling over-flow 33 of large capacity and a drain pipe 34 of limited capacity leading from the bottom of the com-
 10 partment 20. Both pipes 33. and 34 lead to the waste main 30.

The assembled refrigerating apparatus comprises a plurality of the above described sections, in the illustrated construction four,
 15 superimposed one over the other and cooperatively associated by means of certain fluid circuits and heating means in such manner that each phase of the evaporation-absorption refrigerating process takes place
 20 in successive periods in the four sections or individual refrigerating units, so that there may be said to be four periods to each cycle in any unit, the corresponding periods fol-
 25 lowing each other in sequence in the four units.

In the apparatus illustrated, a cooling fluid, as, for example, water, is supplied to each of the outer compartments in sequence from a main 40 by a circulating pump 41
 30 which delivers cooling water through the branch pipe 42 and 43 to two rotary distributing valves 44 and 45. From the distributing valve 44, the pipes 26a, 26b, 26c and 26d lead to outer compartments 17a, 17b, 17c
 35 and 17d of the several sections, the valve being so constructed that a rotation of the valve causes the entering water to be discharged successively into the pipes 26a, 26b, 26c, and 26d. The distributing valve 45 is
 40 similar to the valve 44 and serves upon rotation thereof to deliver cooling water through pipes 32a, 32b, 32c and 32d into the outer compartments 20a, 20b, 20c and 20d of the several sections.

The heat conveying medium which partially fills the inner compartments 16 of the several still-absorbers is circulated continuously by means of a pump 50 which has its inlet connected to the over-flow pipe 25d
 50 of the lowermost section and its discharge delivering into a pipe 51 which leads upwardly into the top of inner compartment 16a of the uppermost section, thence from one compartment 16 to the next below
 55 through over-flows 25 back to the pump 50.

Heat is applied to the heat-conveying fluid by means of the electric resistance member 24 in each compartment 16, which electric resistance members are energized
 60 successively in the several compartments by means of a rotary distributor 53 and branch leads 54a, 54b, 54c and 54d.

The refrigerant, or brine, circulates continuously through the inner compartments
 65 19 of the several evaporator-absorbers. The

over-flow pipe 31 of the lowermost section leads to a pump 55, which discharges through a pipe 56 and branches 57 and 58 to either of two rotary distributing valves 59 and 60.

The valve 59 delivers the refrigerant through a pipe 61 in heat-exchanging relation to a refrigerator, or other body to be cooled, 62, from whence it is delivered
 70 through a pipe 63 to the uppermost of inner compartment 19a, thence from one com-
 75 partment 19 to the next below through over-flows 31 back to the pump 55. The rotary valves 59, 60 are connected so that when the refrigerant is not passing through the
 80 valve 59 to the refrigerator, it is directly returned through the valve 60 and pipe 63 to the compartment 19a and for this purpose the valves are so designed and set that dur-
 85 ing one operating period, the brine flows through the valve 59 to the refrigerator and during the other three periods through the valve 60 back to the compartment 19a.

The rotary distributor valves 44, 45, 59 and 60 and the rotary electrical distributor 53, are operated through a common shaft or stem 65. The stem 65 is rotated through a suitable step-down reduction gear 66 by a motor 67 which serves to drive the cool-
 90 ing water pump 41. The pumps 50 and 55 are also driven from the motor 67 by suitable gearing 68. It follows from the connection of all moving parts of my system to a single motor that the timed relations
 95 of the several successive periodic operations in each of the individual refrigerating units may be maintained in perfect relative phase.

The operation of an apparatus constructed as above set forth is as follows: Con-
 100 sidering, for convenience of description in the present specification, that the refrigerating machine is composed of four units, as illustrated, the refrigerating process may be said to take place in any unit in four peri-
 105 ods of equal duration; a first, or active distillation and absorption period, in which heat is supplied by the electric resistance 24 through the heat-conveying medium in the
 110 compartment 16 to the refrigerant in the still-absorption chamber 11, causing a distillation of the refrigerant which passes over into the chamber 12, and in which cooling
 115 water is supplied to the outer chamber 20 in order to cool the evaporator-absorber 12 and thus to facilitate the absorption of the refrigerant distilled off from the liquor in
 120 chamber 11 in the cool liquor in chamber 12; a second, or transitional period, in which heat is not supplied to the still-absorber 11, nor cooling medium to the evaporator-absorber 12, the action of the prior period
 125 gradually ceasing; a third, or active reverse absorption and evaporation period, in which
 130 water is supplied to the outer compartment

16 in order to cool the weak liquor in the still-absorber 11 to facilitate absorption therein of the refrigerant vapor given off from the evaporator-absorber chamber 12, the refrigeration action during this period being effected by the cooling of brine in the chamber 19; and a fourth or transitional period, in which the operation of the prior period gradually ceases in preparation for the distillation-absorption period of a succeeding cycle. It is to be observed that heat is applied to the still-absorber and cooling water to the evaporator-absorber only during the first period, and that cooling water is applied to the still-absorber only during the third period. The evaporation of the refrigerant vapors from the liquor in the chamber 12 during the third period withdraws the heat from the brine in chamber 19, producing a refrigerating action thereon, the cool brine being available for effecting a resultant cooling action.

In the multiple unit refrigerating machine, the four periods described in the above paragraph occur successively in the several units. Thus, in the position shown in the drawings, the unit A is in the first period, the electric resistance heating the still-absorber 11a and cooling water carrying away heat from the evaporator-absorber 12a to facilitate absorption therein. The unit B is in the fourth transitional period, the heat conveying fluid from the chamber 16a passing to the chamber 16b and preliminarily heating the fluid in the chamber 11b. The unit C is in the third or active refrigerating period, cooling water being supplied to lower the temperature of the still-absorber 11c to facilitate absorption of the refrigerant vapor given off from the strong liquor in chamber 12c, the evaporation effecting a cooling of the brine in chamber 19c. The unit D is in the second transitional stage, the cool heat-conveying medium from the chamber 16c passing to compartment 16d to preliminarily cool the still-absorber 11d in preparation for the third or refrigerating period.

The periods of operation move downwardly in successive periodic intervals. Thus, in the period following that illustrated in the drawings and described in the preceding paragraph, the unit B is in the first period of operation, the unit C is in the fourth, the unit D in the third and the unit A in the second, the progression in the successive periods advancing in the same recurring sequence.

The heat-conveying medium which partly fills at all times the compartments 16 is forced by the pump 50 at such speed that a hot portion thereof is being successively subjected to heat from the electric resistance members 52 in the several units and a cold portion to the cooling water delivered suc-

cessively to the chamber 15 of the several units. This maintenance of a hot and a cold portion in the heat-conveying medium results in greatly increased economy in the heat energy necessary to effect the distillation of the refrigerant vapors.

The refrigerating liquid or brine is likewise circulated at a speed just sufficient to maintain a single portion of the brine in contact with the evaporator-absorber 12 during the third or refrigerating period. This produces a gradual reduction of the temperature of this portion of the brine as it passes from the unit A to the unit D. The cold portion of the brine is directed from the compartment 19d through the rotary distributing valve 60 into the refrigerator 62 at the time when its temperature is the lowest, and where it remains to give up its heat until a succeeding complete cycle of the apparatus has made ready another low temperature portion of brine for the delivery to the refrigerator 62.

It will be apparent that the connection of the pumps, rotary distributing valves, and rotary electrical distributor to a common operating motor insures a perfect time relation in the successive phases or periods of operation throughout the several units, and that, when the apparatus has been once set in operation it will continue to function indefinitely without any special attention.

A further advantage results from the construction of the dumb-bells containing the refrigerant fluid, such as ammonia, in that the dumb-bells are hermetically sealed so that escape of the ammonia, which would result in discomfort to the inmates of the building in which the apparatus is installed and in a decreasing efficiency of the apparatus, is absolutely prohibited.

In fine, the economy in the cost of operation, due to the regenerative effect of the heat-conveying medium, the employment of but a single motor, the absence of wastage of the refrigerating fluids, the automatic and timed regulation of the changes in the operating phases of the several units, and the accumulative cooling of the brine in its passage through the several units, makes a refrigerating machine constructed in accord with the present invention particularly well adapted for use where individual refrigerating plants of limited capacity are desired.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited but is susceptible of various other changes and modifications, without departing from the spirit thereof and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. In combination in a refrigerating apparatus, a plurality of hollow dumb-bells, each hollow dumb-bell having a still-absorber chamber and an evaporator-absorber chamber adapted to contain a refrigerant and an absorbent and connected by a conduit above the normal level of the contents of said chambers, a double-walled receptacle in which each still-absorber chamber is inclosed and which forms an inner compartment and an outer compartment, means connecting the several inner compartments for the circulation of a heat-conveying medium successively therethrough in a closed circulating system, a heating means in each inner compartment, means for filling and emptying the outer compartments with a cooling medium, means for successively energizing the heating means in the several inner compartments, means for controlling the flow of the heat-conveying medium in such manner that the same portion of the said medium is contained within any inner compartment during a heating period therein, thereby producing in the heat-conveying medium a zone of highly heated medium and zone of relatively cool medium, means for passing a cooling medium through each outer compartment during the period in which the relatively cool heat-conveying medium is being circulated through the corresponding inner compartment, thereby increasing the temperature difference between the hot and cool zones of the heat-conveying medium, means for continuously circulating a refrigerating agent in successive heat-exchanging relations to the evaporator-absorbers, means for controlling the flow of refrigerating fluid in such manner that the same portion of the fluid is brought into heat-exchanging relation contact with each evaporator-absorber during periods corresponding to the periods in which the zones of high heated and relatively cool heat-conveying mediums traverse the inner compartments in which an associated still-absorber is located, whereby a certain portion of the refrigerating fluid is successively reduced in temperature.
2. In combination in a refrigerating apparatus, a plurality of hollow dumb-bells, each hollow dumb-bell having a still-absorber chamber and an evaporator-absorber chamber adapted to contain a refrigerant and an absorbent and connected by a conduit above the normal level of the contents of said chambers, two series of superimposed double-walled receptacles in number corresponding to the number of hollow dumb-bells, each receptacle in each series having an inner compartment and an outer compartment, the still-absorber chambers being supported within the inner chambers

of a first series and the evaporator-absorbers being supported in corresponding inner chambers of a second series of said receptacles, means for circulating a heat conveying medium continuously through the inner compartments of said first series of receptacles in a closed cycle, a heating means in each inner compartment of said first series, means for intermittently and successively energizing said heating means, means for intermittently and successively passing a cooling medium through the outer compartments of said first series, means for circulating a refrigerating fluid continuously through the inner compartments of said second series in a closed cycle, means for intermittently and successively passing a cooling medium through the outer compartments of said second series, and means for coordinating and controlling the energizing of the heating means, the flow of the heat-conveying medium, the refrigerating fluid and the cooling medium in such manner as to produce in the dumb-bells successive and intermittent periods of distillation of refrigerant from each still-absorber and of absorption of the refrigerant in the connection evaporator-absorber, alternating successive and intermittent periods of evaporation of the refrigerant from each evaporator-absorber and of absorption in the connected still-absorber, and a progressive cooling of the refrigerating fluid.

3. In combination in a refrigerating apparatus, a plurality of superimposed refrigerating units; each unit comprising a pair of receptacles, spaced apart and each having inner and outer compartments, and a hollow dumb-bell adapted to contain a refrigerant and an absorbent and having a still-absorber chamber, and evaporator-absorber chamber and a conduit connecting the chambers above the normal level of the chamber contents, the still-absorber chamber being supported within the inner compartment of one receptacle and the evaporator-absorber being supported in the inner compartment of the other receptacle, means for circulating a heat-conveying medium continuously through the inner compartments in which the still-absorbers are supported in a closed cycle, a heating means in each such inner compartment, and means for successively energizing the heating means in the several units, said heat conveying medium being so circulated through the several inner compartments that a definite portion thereof is always in contact with an energized heating means.

In testimony whereof, I have hereunto subscribed my name this 7th day of December 1921.

ALEXANDER T. KASLEY.