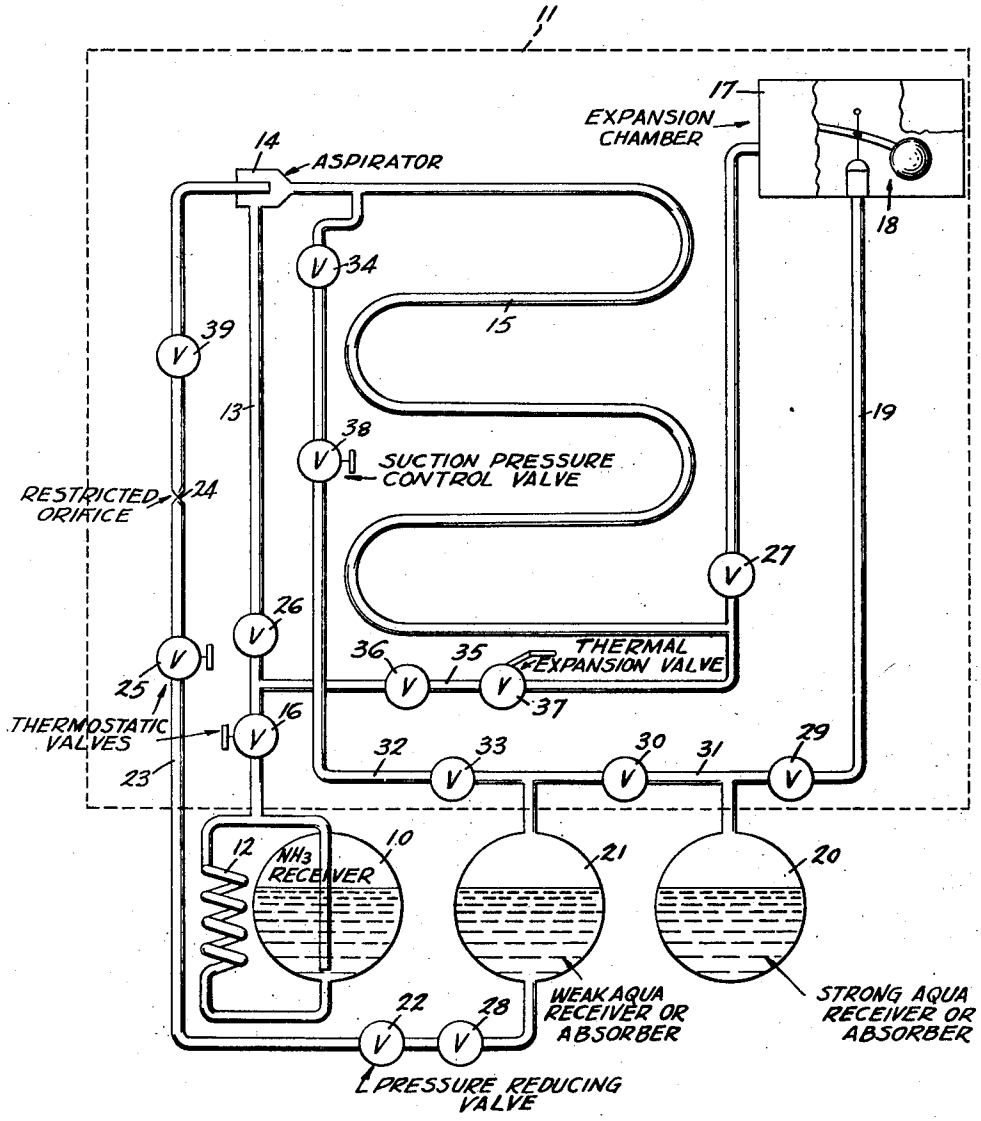
Feb. 21, 1950 C. D. HARTMAN, JR., ET AL 2,498,369

SPLIT AMMONIA ABSORPTION SYSTEM

Filed Sept. 12, 1946



INVENTORS.
CHARLES D. HARTMAN, JR.
ALMON J. CORDREY
BY Campbell, Brumbaugh & Free
their ATTORNEYS.

Patented Feb. 21, 1950 2,498,369

UNITED STATES PATENT OFFICE

2,498,369

SPLIT AMMONIA ABSORPTION SYSTEM

Charles D. Hartman, Jr., New York, and Almon J. Cordrey, Garden City, N. Y.

Application September 12, 1946, Serial No. 696,598

13 Claims. (Cl. 257—3)

1

This invention relates to heating systems and it relates particularly to systems for heating railway cars or other mobile vehicles that are used for transporting perishable produce, such as, vegetables, fruits and the like.

Refrigerator cars, when used for transporting perishable produce in the wintertime, may be subjected to such low temperatures that the produce therein may be damaged by freezing.

It has been proposed heretofore to provide heating systems which can be set into operation in order to protect the produce and retain it at a sufficiently high temperature to prevent the produce from freezing. Such heating devices may consist of coal, oil, or gas fired stoves, which, of course, occupy space in such refrigerator cars. Inasmuch as the space available for loading the cars is limited, it is desirable to provide a heating system which does not occupy much space, and preferably no more space than is normally occupied by the refrigerating means normally provided in such refrigerating cars. Moreover, such heating means should be relatively fool proof and should be of such nature that ready control thereof and minimum fire hazard are assured.

In accordance with the present invention, we have provided heating systems for refrigerator cars and other mobile vehicles or chambers in which heat is generated by the exothermic reaction produced by absorption of ammonia gas in weak aqua ammonia. The car may be heated by supplying expanded ammonia gas to a coil or heat exchanger which contains a dilute solution of aqua ammonia whereby the gas will be absorbed, with the resultant generation of heat and the production of a stronger ammonia solution. By controlling the pressure at which the ammonia is introduced into the system and the pressure of the gas and aqua ammonia in the coil and further by controlling the rate at which the stronger aqua ammonia is discharged from the system, it is possible to heat the coils or heat exchangers in the car sufficiently to offset heat loss through the walls of the car even at low temperatures, and thereby maintain a temperature in the refrigerator car sufficiently high to preserve foodstuffs or other articles carried therein against freezing.

In a typical system, the refrigerator car or other vehicle may be provided with a receiver for liquid ammonia at about the temperature on the exterior of the car. This receiver and a second receiver for weak aqua ammonia preferably are placed on the exterior of the car. The

2

ammonia is allowed to expand through a coil and heat exchanger preferably outside the car where it absorbs heat from the atmosphere, even though the atmosphere is at a very low temperature. This evaporated or expanded ammonia and the weak aqua ammonia are supplied to a coil or heat exchanger within the refrigerating chamber where the ammonia goes into a solution in the weak aqua ammonia thereby heating the coil. As the stronger solution is formed, it is allowed to escape from the coil after giving off some of this heat and may be delivered by the pressure in the system to a receiver, preferably also on the exterior of the car. By including a relief valve that permits the strong aqua ammonia to escape from the coil, the interior of the car may be maintained above freezing temperatures. The relief valve may suitably comprise an expansion chamber having a float controlled valve associated therewith which allows the strong aqua ammonia to escape from the coil after it has travelled through the coil.

The system described generally above may be used for refrigerating the interior of the car by reversing the cycle and utilizing the ammonia receiver noted above for receiving ammonia for expansion into the coils and utilizing the strong ammonia and weak aqua ammonia receivers as absorbers for the expanded ammonia in the coil. Thus, by the provision of suitable valves and connections between the receivers and the heat exchange coils, it is possible to use substantially the same system for heating and cooling the cars, thereby conserving space and simplifying the equipment required for heating and cooling the car.

For a better understanding of the present invention, reference may be had to the accompanying drawing in which the single figure is a diagrammatic illustration of a typical system for heating and cooling refrigerating cars and other devices.

As indicated above, the heating system embodying the present invention operates on the principle that the absorption of ammonia gas in a weak aqua ammonia solution generates heat. The heating effect of such a reaction may be taken advantage of in many different systems, such as the system illustrated in the drawing. This system includes a first tank or receiver 10 which is adapted to be charged with liquid ammonia and inasmuch as it may be disposed on the exterior of the chamber 11, illustrated in dotted lines, the ammonia will be at about the temperature of the surrounding atmosphere. The

liquid ammonia may be supplied to the receiver 10 at servicing stations located at suitable points along a railroad. The receiver 10 may be provided with a heat exchanger coil or surface 12 connected to the top and bottom of the receiver where the ammonia may evaporate and absorb heat from the atmosphere. The receiver 10 is connected by means of a conduit 13 to an aspirator 14 which directs the gas into the heating or cooling coil 15 within the chamber 11.

The conduit 13 is provided with a thermostatically controlled valve 16 which may be set to be open at temperatures below about 34°, for example, and to be closed at temperatures above 34° so that the ammonia is supplied to the coil 15 when the temperature in the chamber approaches freezing. The thermostatic valve preferably is an adjustable type with reversible connections so that it also can be adjusted to close at a low temperature and open at a higher temperature. The opposite end of the coil 15 from the aspirator 14 is connected to an expansion chamber 17 which is gas-tight and is provided with a float-controlled valve 18 of conventional type. The valve 18 is adapted to open when the chamber 17 is about full and close when the liquid therein is discharged through the conduit 19. This conduit is connected to a receiver 20 which collects the liquid from the float chamber 17 and coil 15 as it is discharged.

Weak aqua ammonia, for example, a 6% solution of ammonia in water, for absorbing the ammonia gas is supplied from a third receiver 21 also mounted outside the chamber 11. The weak aqua is maintained under a pressure of about 30 to 80 pounds per square inch by charging the receiver with compressed air. The weak aqua flows through a pressure reducing valve 22 in the conduit 23 into the aspirator 14 and mixes with the ammonia gas and flows through the coil 15. The rate of flow of weak aqua may be controlled by a restricted orifice 24 in the conduit 23. The orifice 24 may be of a diameter, for example, to permit the weak aqua to be supplied at the rate of about three gallons per minute to the coil 15. The conduit 23 is also provided with a thermostatic valve 25 for shutting off the flow of weak aqua to the coil 15, when the temperature in the chamber exceeds a predetermined value, for example, 34° F.

The above described system contains all the elements necessary for heating the car and operates as follows:

The ammonia in the receiver 10, and in exchanger surface 12 expands into gas and passes through the conduit 13 into the coil 15 where it dissolves in the weak aqua ammonia supplied from the receiver 21. As the ammonia dissolves, it gives off heat at the rate of about 840 B. t. u.'s per pound of ammonia. The specific gravity of the liquid in the coil 15 changes and there is a tendency, of course, for the concentration of the liquid in the pipes to become equalized with the result that flow takes place in the coil 15 toward the chamber 17. This flow is also influenced by the pressure of the ammonia gas and the flow into coil 15 of the weak aqua ammonia.

The float valve 18 is utilized to discharge strong aqua from the coil, intermittently, when the mixture of NH_3 gas and weak aqua have sufficiently increased the volume of the mixture in the coil to fill the expansion chamber in the float valve body. When the float is raised sufficiently the float valve opens and discharges the strong aqua ammonia into the receiver 20.

As the strong aqua tank is exposed to the temperature of the outside atmosphere, which is at or below 30° F. when heat is required inside the car, the pressure in the strong aqua tank 20, connected to chamber 17 through conduit 19 is at all times below the pressure in coil 15, and the strong aqua from coil 15 will flow through chamber 17 into the receiver 21 by pressure differential.

Under the conditions specified above, the temperature of the coil 15 will be raised by the generation of heat of absorption sufficiently to maintain the car above freezing temperature even when the outside temperature is as low as —20° F., assuming of course, that the car is well insulated. Coil temperatures as high as 55° F. are easily attained. It will be understood that the operation of the system is not continuous for the supply of ammonia gas will be shut off by the thermostatic valve 16 when the temperature of the car is raised sufficiently. Similarly the supply of weak aqua will be shut off by means of the thermostatically-controlled valve 25.

This system can be modified to permit it to be used for cooling cars during the summer months. Essentially the changes consist in the addition of suitable valves and conduits for reversing the cycle of operation. Thus a manually operated valve 26 may be placed in the conduit 13, a valve 27 interposed between the coil 15 and the chamber 17, a valve 28 placed in the conduit 23 between the receiver 21 and the pressure reducing valve 22. A valve 29 is placed in the conduit 19 and a conduit 31 having a valve 30 therein is provided for connecting the receivers 20 and 21. Another conduit 32 is added to connect the receiver 21 to the coil 15 downstream of the aspirator 14. The conduit 32 may be provided with valves 33 and 34 at its opposite ends. Another conduit 35 is connected to the conduit 13 between the valves 16 and 26 and to the remote end of the coil 15. A manually operated valve 36 and a thermostatically controlled thermal expansion valve 37 are interposed in the conduit 35.

For efficient operation of the cooling system it is necessary to provide a suction pressure valve, preferably thermostatically controlled, as disclosed in the Cordrey application Ser. No. 565,436, between the discharge end of an expansion coil 15 and the ammonia absorber. In this system such a suction pressure valve 38 is placed in the conduit 32 between the valves 33 and 34. The conduit 23 may be provided with another valve 39 near the aspirator 14.

The system described above and shown in the drawings may be used for heating or for cooling. The system is conditioned for heating by opening the valves 26, 27, 28, 29 and 39 and closing the valves 30, 33, 34 and 36 whereby the cycle of operation described above takes place.

To provide refrigeration with the system, the valves 26, 27, 28, 29 and 39 are closed and the valves 30, 33, 34 and 36 are opened. This adjustment of the valves causes the receiver 10 to be connected through the valve 16, conduit 13 and conduit 35 to the lower end of the coil 15. The receivers 20 and 21 are connected to the other end of the coil through the conduit 32. The float valve chamber and the conduit 23 are disconnected from the fluid circuit.

The receiver 10 is filled with liquid ammonia, preferably precooled or subcooled and air pressure is applied to the liquid to force it into the coil 15. The valve 36 may be used as a pres-

sure reducing valve and the thermal expansion valve 37, as well as the thermostatic valve 16, control the flow of the ammonia to the coil. The thermostatic valve 16 may be adjusted to close at a predetermined low temperature, for example 38° F. The ammonia evaporates in the coil 15 and the coil temperature is regulated by the suction pressure control valve 38 as described in application Ser. No. 565,436, the escaping gas flowing to the receivers 20 and 21 which are filled with weak aqua ammonia for absorbing the ammonia gas.

From the preceding description, it will be apparent that we have provided a system which may be utilized either for heating or for cooling and which is automatic after it has been set into operation.

It will be understood that the arrangement of the system is susceptible to considerable modification, particularly in the design of the coils, the receivers, the valves used therein and other details thereof. Therefore, the forms of the invention described herein should be considered as illustrative only.

We claim:

1. A heating system for a chamber comprising a first heat exchange coil within said chamber, a second heat exchange coil outside of said chamber, means for supplying strong ammonia to said second coil for expansion therein and absorption of heat and then to said first coil, means for supplying weak aqua ammonia to said first coil to absorb said strong ammonia and thereby generate heat and form strong aqua ammonia in said first coil, and means for collecting said strong aqua ammonia from said first coil and discharging it intermittently.

2. A heating system for a mobile vehicle comprising a coil within said vehicle, a reservoir for receiving ammonia under pressure carried by said vehicle, a receiver for weak aqua ammonia under pressure carried by said vehicle, means connecting said reservoir and said receiver to said coil for supplying said coil with said weak aqua ammonia and said ammonia for absorption of said ammonia in said weak aqua ammonia to produce strong aqua ammonia and heat, and means for receiving said strong aqua ammonia from said coil and discharging it intermittently.

3. A heating system for a mobile vehicle comprising a coil within said vehicle, a reservoir for receiving ammonia carried by said vehicle, a receiver for weak aqua ammonia under pressure carried by said vehicle, means connecting said reservoir and said receiver to said coil for supplying said coil with said weak aqua ammonia and said ammonia for absorption of said ammonia in said weak aqua ammonia to produce strong aqua ammonia and heat, and means for receiving said strong aqua ammonia from said coil, and means intermediate said coil and said last-named receiving means for controlling the rate of discharge of said strong aqua ammonia from said coil.

4. A heating system for a chamber comprising a first heat exchange coil within said chamber, a second heat exchange coil outside of said chamber, means for supplying ammonia to said second coil for evaporation therein and absorption of heat and then to said first coil, means for supplying weak aqua ammonia to said first coil to absorb the ammonia vapor and thereby produce strong aqua ammonia and generate heat in said first coil, means for receiving said strong aqua ammonia from said first coil, and means intermediate said coil and said last-named receiving means for controlling the flow of said strong aqua ammonia from said first coil to said receiving means.

5. A heating system for a refrigerating chamber comprising a heat exchanging coil in said chamber, means for supplying weak aqua ammonia to said coil, means for supplying ammonia vapor to said coil for absorption in said aqua ammonia to form strong aqua ammonia and generate heat, an expansion chamber connected to said coil for receiving said strong aqua ammonia from said coil, a float valve in said chamber for discharging said strong aqua ammonia from said chamber, and a receiver for said strong aqua ammonia connected to said chamber.

6. A heating system for a refrigerating chamber comprising a heat exchanging coil in said chamber, means for supplying weak aqua ammonia under pressure to said coil, means for supplying ammonia vapor to said coil for absorption in said aqua ammonia to form strong aqua ammonia and generate heat, an expansion chamber connected to said coil for receiving said strong aqua ammonia from said coil, a float valve in said chamber for discharging said strong aqua ammonia from said chamber, and a receiver for said strong aqua ammonia connected to said chamber.

7. A heating system for a refrigerating chamber comprising a heat exchanging coil in said chamber, a receiver for ammonia connected to one end of said coil, a receiver for weak aqua ammonia under pressure connected to said one end of said heat exchanging coil, means responsive to the temperature of said chamber for controlling the flow of ammonia to said heat exchanging coil, means responsive to the temperature of said chamber for controlling the flow of weak aqua ammonia to said heat exchanging coil, a closed expansion chamber connected to the other end of said heat exchanging coil, a receiver connected to said expansion chamber, and a float valve in said expansion chamber controlling flow from said expansion chamber to the last-mentioned receiver.

8. A heating system for a refrigerating chamber comprising a heat exchanging coil in said chamber, a receiver for ammonia connected to one end of said coil, a receiver for weak aqua ammonia under pressure connected to said one end of said heat exchanging coil, means for controlling the rate of flow of weak aqua ammonia to said heat exchanging coil, means responsive to the temperature of said chamber for controlling the flow of ammonia to said heat exchanging coil, means responsive to the temperature of said chamber for controlling the flow of weak aqua ammonia to said heat exchanging coil, a closed expansion chamber connected to the other end of said heat exchanging coil, a receiver connected to said expansion chamber, and a float valve in said expansion chamber controlling flow from said expansion chamber to the last-mentioned receiver.

9. A heating system for a refrigerating chamber comprising a heat exchanging coil in said chamber, a receiver for ammonia connected to one end of said coil, an evaporating coil interposed between said receiver and said heat exchanging coil, a receiver for weak aqua ammonia under pressure connected to said one end of said heat exchanging coil, means responsive to the temperature of said chamber for controlling the flow of ammonia to said heat exchanging coil, means responsive to the temperature of said chamber for controlling the flow of weak aqua ammonia to said

heat exchanging coil, a closed expansion chamber connected to the other end of said heat exchanging coil, a receiver connected to said expansion chamber, and a float valve in said expansion chamber controlling flow from said expansion chamber to the last-mentioned receiver.

10. A heating system for a refrigerating chamber comprising a heat exchanging coil in said chamber, a receiver for ammonia connected to one end of said coil, an evaporating coil interposed between said receiver and said heat exchanging coil, a receiver for weak aqua ammonia under pressure connected to said one end of said heat exchanging coil, means for controlling the rate of flow of weak aqua ammonia to said heat exchanging coil, means responsive to the temperature of said chamber for controlling the flow of ammonia to said heat exchanging coil, means responsive to the temperature of said chamber for controlling the flow of weak aqua ammonia to said heat exchanging coil, a closed expansion chamber connected to the other end of said heat exchanging coil, a receiver connected to said expansion chamber, and a float valve in said expansion chamber controlling flow from said expansion chamber to the last-mentioned receiver.

11. A heating and cooling system for a refrigerating chamber comprising a heat exchanging coil in said chamber, a receiver connected to one end of said coil for supplying vapor to said coil, a first thermostatically controlled valve between said receiver and said coil for connecting and disconnecting said receiver and said coil, a second receiver connected to said one end of said coil for suplying liquid under pressure to said coil, means restricting the flow of liquid to said coil, a second thermostatically controlled valve between said second receiver and said coil for connecting and disconnecting said receiver and said coil, a third receiver, an expansion chamber interposed between and connected to the other end of said coil and said third receiver, and a float-controlled valve in said expansion chamber for controlling flow from said expansion chamber to said third receiver.

12. A heating and cooling system for a refrigerating chamber comprising a heat exchanging coil in said chamber, a receiver connected to one end of said coil for supplying vapor to said coil, a first thermostatically controlled valve between said receiver and said coil for connecting and disconnecting said receiver and said coil, a second receiver connected to said one end of said coil for supplying liquid under pressure to said coil, means restricting the flow of liquid to said coil, a second thermostatically controlled valve between said second receiver and said coil for connecting and disconnecting said receiver and said coil, a third receiver, an expansion chamber interposed between and connected to the other end of said coil and said third receiver, a float-controlled valve in said expansion chamber for controlling flow from said expansion chamber to said third receiver, a first connection from said one end of said coil to said second and third receivers, a suction pressure control valve in said connection, a second connection interposed between said first thermostatically controlled valve and said other end of said coil, a thermal expansion valve in said second connection, and means for selectively reversing connections between said receivers and said coil, and connecting and disconnecting said expansion chamber for selectively heating and cooling said coil.

13. A heating and cooling system for a refrigerating chamber, a heat exchanging coil, a first receiver, a first connection between said first receiver and one end of said coil, a thermostatically controlled valve responsive to the temperature of said chamber in said connection, a second connection between said receiver and the other end of said coil, a thermal expansion valve in said second connection, a second receiver, first means connecting said second receiver to said one end of said coil, a flow control valve and a thermostatically controlled valve responsive to the temperature of said chamber in said first connecting means, a third receiver, an expansion chamber means connecting said other end of said coil, said expansion chamber and said third receiver in series, a float-controlled valve in said expansion chamber for connecting and disconnecting said third receiver and said expansion chamber, a third connection between said one end of said coil and said second and third receivers, a suction pressure control valve in said third connection, and manually controlled valves in said connections and connecting means for reversing the connections between said receivers and coil to selectively heat and cool said refrigerating chamber.

CHARLES D. HARTMAN, JR.
ALMON J. CORDREY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
444,532	Holden	Jan. 13, 1891
2,064,040	Smith	Dec. 15, 1936
2,374,972	Biehl	May 1, 1945