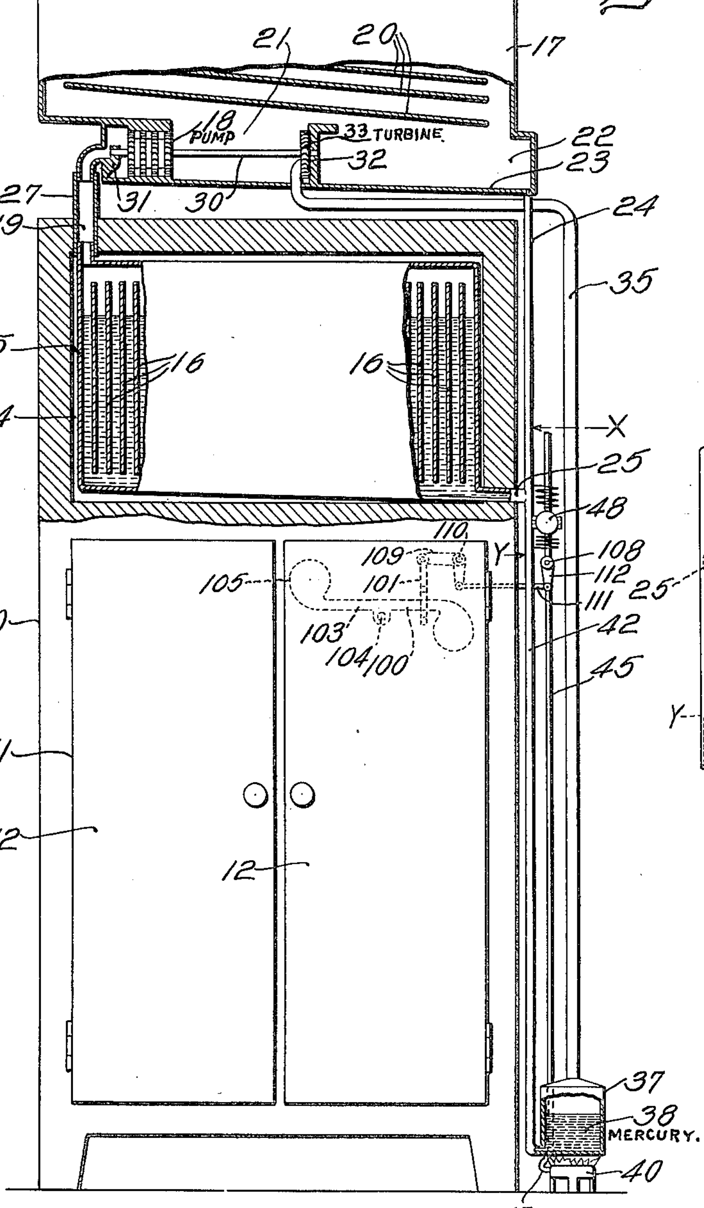
March 11, 1924. 1,486,551

C. G. SMITH

REFRIGERATING APPARATUS

Filed Jan. 8, 1918

Fig. 1.



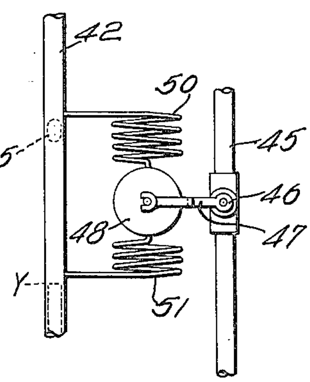


Fig. 2.

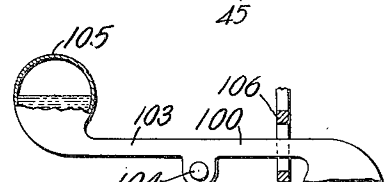


Fig. 3.

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UNITED STATES PATENT OFFICE.

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REFRIGERATING APPARATUS.

Application filed January 8, 1918. Serial No. 210,841.

To all whom it may concern:

Be it known that I, CHARLES G. SMITH, a citizen of the United States, residing at Cambridge, in the county of Middlesex and State of Massachusetts, have invented certain new and useful Improvements in Refrigerating Apparatus; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The present invention relates to refrigerating apparatus and more particularly to self-contained apparatus of this type adapted to be operated for long continued periods without replenishment of the cooling medium.

The desirability of a small refrigerating apparatus, which shall maintain the temperature of a room or box within the desired limits has long been recognized, but apparatus of this type which have been heretofore devised have required a considerable space for their installation, have been inefficient, and furthermore require more or less constant attention on the part of the operator.

It is an object of the present invention to provide a refrigerating apparatus which is compact in its construction, and which maintains the temperature automatically within desired limits, without any substantial attention on the part of the operator.

With this object in view a feature of the invention contemplates the provision of an evaporator partially filled with water and located in the receptacle to be cooled, a condenser located outside of the receptacle, and a pump interposed between the evaporator and condenser and adapted to maintain a vacuum over the surface of the water in the evaporator and discharge the water vapor produced by the presence of the vacuum into the condenser, and connections between the condenser and the lower portion of the evaporator for returning the condensed water vapor to the evaporator.

A further feature of the present invention contemplates the provision of a turbine directly connected to the water pump, a heater containing liquid mercury, connections between the heater and turbine to cause the mercury vapor under pressure to drive the turbine, and connections between the water vapor condenser into which the turbine exhausts and the mercury heater to return the liquid mercury after condensation to the heater.

With this construction a self-contained system is provided for handling the cooling liquid or water and the fluid which furnishes the motive or propelling power to the pump.

Still further features of the invention consist in certain novel features of construction, combinations and arrangements of parts hereinafter described and claimed, the advantages of which will be obvious to those skilled in the art from the following description.

In the accompanying drawings illustrating the preferred form of the invention, Figure 1 represents a front elevation of a suitable receptacle with the refrigerating apparatus embodied therein; Fig. 2 is a detail illustrating the mechanism for controlling the pressure of mercury vapor within the heater; and Fig. 3 is a detail illustrating the thermostat for controlling the fuel supply.

The illustrated embodiment of the invention is applied to a refrigerator box 10 of the usual type, having a chamber 11 in the lower portion closed by doors 12 and adapted to receive the food, and a cooling chamber 14 in the upper portion which ordinarily receives the ice.

It is well understood by those skilled in the art that the evaporation of water absorbs heat from the surrounding atmosphere, and accordingly the present invention utilizes this principle to abstract heat from the interior of the refrigerator box and maintain the temperature at the desired point. The evaporator comprises a metal container 15 which fits within the space 14, and is provided with a series of transverse partitions 16 connected with the walls of the container and adapted to facilitate the transmission of heat from the walls to the interior of the container. As shown clearly in the drawing, this container is partially filled with water, which is automatically maintained at a substantially constant level as hereinafter described. Located above the refrigerator box is a closed condenser 17 which is connected with the container through a pump 18 and communicating passage 19. The walls of condenser 17 are cooled by air or any other well known cooling medium contacting with the exterior surface of the condenser. The pump 18 is preferably one of the well-known multistage pumps suitably designed to handle the comparatively large volume of water vapor and adapted to maintain a constant vacuum over the surface of the liquid in the evaporator, and to discharge the water vapor thus formed into the condenser at a substantially higher pressure. In order to cause the heat contained in the water vapor to be transmitted to the walls of the condenser and readily absorbed by the surrounding air, the condenser is provided with a series of baffle plates 20 which are inclined downwardly toward that end of the condenser which is the more remote from the passage 21 leading to the pump. These baffle plates serve to collect the condensed water vapor and direct the water into a chamber 22 formed below the condenser, and having an inclined bottom 23 which communicates with the upper end of a return pipe 24. This return pipe 24 is connected with the bottom of the evaporator through a pipe 25, and causes the water within the evaporator to be constantly replenished as the water vapor is withdrawn from the evaporator by the pump 18. In the normal operation of this apparatus then, water vapor is being continually withdrawn from the top of the container by the pump 18, and liquid water is being continually supplied to the bottom of the container through the passage 25, the level of the water in the pipe 24 standing somewhat lower than the level of the water within the evaporator, as indicated at X, due to the difference in pressure on opposite sides of the pump 18.

In order to insulate the evaporator and the interior of the refrigerator box from the surrounding atmosphere and the condenser, the connection 19 between the top of the evaporator and the suction side of the pump 18 consists of a tube 27 of material which is a poor conductor of heat.

In order to operate the pump efficiently, a small turbine is connected directly to the pump shaft, and is driven by mercury vapor generated in a heater which is directly connected to the turbine. The speed of the pump is conveniently varied by suitably varying the pressure of the mercury vapor, and as the thermal efficiency of mercury is exceptionally high, this apparatus forms an extremely compact and efficient means for operating the pump. Furthermore, the condenser for the water vapor is employed for condensing the mercury vapor, and both the mercury and water when condensed to liquid form are returned through the same pipe 24, the two liquids automatically separating from each other on account of the difference in specific gravity. As shown clearly in Fig. 1, the pump 18 is supported upon a shaft 30 journaled at opposite ends in brackets 31 and 32 and having a turbine 33 mounted thereon. This turbine is preferably of the impulse type, and is connected with a main feed pipe 35 which contains the mercury vapor under pressure. This feed pipe passes outside of the refrigerator box, and communicates with the upper portion of a heater 37 containing liquid mercury, as indicated at 38. The requisite heat for vaporizing the mercury under pressure is imparted by a burner indicated at 40 and located beneath the heater 37. The mercury vapor is exhausted from the turbine 33 into the condenser 17 where it is transformed into liquid mercury and returned with the water into the pipe 24. This pipe, as shown clearly in Fig. 1, is connected with a pipe 42 which connects directly with the bottom or lower portion of the heater 37, the two pipes forming in effect a vertical rise which extends from the heater to the condenser. In the normal operation of the apparatus the mercury column in the pipe 42 stands at about the level indicated at Y, or considerably higher than the mercury within the heater 37, the difference in level being due to the difference in pressure within the pipes 35 and 42. It will be noted that this mercury level, however, is below the water passage 25, and does not interfere with the continuous flow of water from the pipe 24 back to the evaporator 15. The mercury column in the pipe 42 serves to automatically feed the heater 37 without the interposition of any valves whatsoever.

As the pressure of mercury vapor within the pipe 35 increases, the mercury column within the pipe 42 rises, and in order to maintain a substantially constant pressure of mercury vapor, mechanism is provided for automatically regulating the burner 40 in accordance with the level of the mercury column in the pipe 42. To this end the fuel pipe 45 which supplies the burner is provided with a valve indicated at 46 and operated by an arm 47. This arm is connected to a hollow vessel 48 supported above and below by coils of light tubing 50 and 51, respectively, which are connected at opposite ends to the receptacle 48 and to the riser 24. The normal level of the mercury is below the connection between the coil 51 and the riser, and when this mercury level rises the liquid mercury flows through the coil 51 and thence into the vessel, displacing the water until the weight of the mercury is sufficient to compress the coil of tubing 51 and operate the arm 47 to either partially or wholly close the valve 46. When the supply of fuel to the burner is diminished, the pressure within the heater 37 gradually drops, causing the mercury level to be lowered until the vessel 48 is again free to be returned to its normal position, in which it is balanced between the two coils of tubing 50 and 51. It will be obvious that this construction serves as an automatic regulation of the turbine 33, as the speed of this turbine is directly dependent upon the pressure of the mercury vapor supplied to it.

It is likewise desirable to automatically control the temperature within the refrigerator by varying the volume of liquid vapor transferred from the evaporator into the condenser. To this end the fuel feed to the burner is automatically controlled thermostatically in accordance with the temperature within the compartment to be cooled. As will be observed from an inspection of Figs. 1 and 3 of the drawings, a vessel 100 is pivoted at 104 in the lower portion of the refrigerator and comprises a stem 103 and oppositely disposed bulbs 105 connected to the stem. The vessel is entirely sealed from the atmosphere and contains a liquid, for example alcohol, which is supported in the lower bulb 105 by a flexible diaphragm 102. The remaining portion of this bulb is filled with air which is expanded or contracted in accordance with the temperature surrounding the bulb. The vessel is so designed that at a normal temperature within the refrigerator, for example 40 degrees, the weight of the liquid in the vessel upon opposite sides of the fulcrum 104 is balanced. The space in the upper bulb 105 above the liquid is filled with liquid vapor at a pressure substantially equal to the pressure of the air within the lower bulb 105 at normal temperatures within the refrigerator. If the temperature within the refrigerator rises, however, the consequent flexing of the diaphragm 102 forces alcohol from the lower into the upper bulb 105 and overbalances the vessel. A rocker valve 108 is located in the fuel pipe 42 and is provided with an arm 112 connected at its lower end to a link 111 which slides in the wall of the refrigerator. This link is connected at its opposite end to one arm of a bell crank 109 fulcrumed within the refrigerator at 110 and having a second arm connected to an operating rod 101 provided with a pair of stops 106 and 107 which are adapted to be engaged by the stem 103 of the containing vessel. With this construction, when the vessel is rocked in either direction due to a rise or fall in the temperature, the operating rod 101 is moved vertically to open or close the valve 108.

It will be observed that by utilizing water as a cooling fluid, and mercury as a working fluid of greater density than the cooling fluid, it is possible to design a refrigerating system having a minimum of moving parts from which all valves are eliminated, and at the same time utilize to the utmost the thermo dynamic advantages of mercury in a heat engine.

While it is preferred to employ the specific construction and arrangement of parts shown and described, it will be understood that this construction and arrangement is not essential except so far as specified in the claims, and may be changed or modified without departing from the broader features of the invention.

The invention having been described, what is claimed is:

1. A refrigerating apparatus comprising an evaporator, a condenser, a mercury heater, a vertical riser connecting the condenser with the evaporator and mercury heater, a pump located between the evaporator and condenser, a mercury turbine connected to the pump and adapted to discharge into the condenser, and connections between the turbine and heater.

2. Control means for a refrigerating apparatus comprising a vapor turbine, a heater for generating actuating vapor for the turbine adapted to contain mercury, a riser connected to the heater and adapted to maintain a constant supply of liquid mercury to the heater, a burner, a fuel supply pipe for the burner, and connections between the riser and fuel supply pipe for regulating the supply of fuel to the burner in accordance with the mercury pressure within the heater.

3. Refrigerating apparatus including an evaporator tank and a pressure tank at a lower level than the evaporator tank, a condenser, a pump for creating suction within the evaporator, said pump discharging into the condenser, a turbine for actuating the pump having its discharge opening into the condenser, means for conducting actuating vapor from the pressure tank to the turbine, a heater for the pressure tank, a fuel supply line for the heater having control valves, a discharge pipe for the condenser connected to the tanks, a shunt connection on the discharge pipe having operative connection with one of the fuel control valves for operating the valve proportionate to pressure in the pressure tank, and thermostatic means adjacent the evaporating tank for actuating another of the valves proportionate to temperature variations.

4. Refrigerating apparatus including an evaporator for a cooling liquid of given density, a boiler for a liquid of greater density than said cooling liquid, means for supplying heat to said boiler, a condenser, means whereby vapor from the denser liquid propels the vapor of the cooling liquid into said condenser, said last means discharging the vapor of the denser liquid into said condenser, a discharge conduit from said condenser to said boiler, said conduit having an upright portion in which the denser liquid collects at the bottom with the cooling liquid thereabove, and an outlet for the cooling liquid above the level of the denser liquid.

5. Refrigerating apparatus including an evaporator for a cooling liquid of given

density, a boiler for a liquid of greater density than said cooling liquid, means for supplying heat to said boiler, a condenser, means whereby vapor from the denser liquid propels the vapor of the cooling liquid into said condenser, said last means discharging the vapor of the denser liquid into said condenser, a discharge conduit from said condenser to said boiler, said conduit having an upright portion in which the denser liquid collects at the bottom with the cooling liquid thereabove, and an outlet in said conduit for the cooling liquid, said outlet being intermediate said condenser and the level of the denser liquid in said conduit and discharging into said evaporator.

6. Refrigerating apparatus including an evaporator for water, a boiler for mercury, means for supplying heat to said boiler, a condenser, means whereby mercury vapor from said boiler propels water vapor from said evaporator into said condenser, said last means discharging the mercury vapor into said condenser, a discharge conduit from said condenser to said boiler, said conduit having an upright portion connected at its lower end to the boiler below the level of the mercury therein, whereby mercury collects at the bottom of said portion with the water thereabove, and an outlet for the water above the level of the mercury.

7. Refrigerating apparatus including an evaporator for a cooling liquid of given density, a boiler for a liquid of greater density than said cooling liquid, means for supplying heat to said boiler, a condenser, means whereby vapor from the denser liquid propels the vapor of the cooling liquid into said condenser, said last means discharging the vapor of the denser liquid into said condenser, a discharge conduit from said condenser to said boiler, said conduit having an upright portion in which the denser liquid collects at the bottom with the cooling liquid thereabove, an outlet for the cooling liquid above the level of the denser liquid, and means connected with said conduit responsive to variations of the level of the denser liquid therein with variations of the vapor pressure in said boiler to vary the heat supplied to said boiler.

8. Refrigerating apparatus including an evaporator for a cooling liquid of given density, a boiler for a liquid of greater density than said cooling liquid, means for supplying heat to said boiler, a condenser, means whereby vapor from the denser liquid propels the vapor of the cooling liquid into said condenser, said last means discharging the vapor of the denser liquid into said condenser, a discharge conduit from said condenser to said boiler, said conduit having an upright portion in which the denser liquid collects at the bottom with the cooling liquid thereabove, an outlet for the cooling liquid above the level of the denser liquid, said conduit including a yieldingly supported reservoir in series between the condenser and boiler, and means responsive to variations in the level of said reservoir with variations in the pressure of said boiler to automatically vary the heat supplied to said boiler.

9. Refrigerating apparatus including an evaporator for a cooling liquid of given density, a boiler for a liquid of greater density than said cooling liquid, means for supplying heat to said boiler, a condenser, means whereby vapor from the denser liquid propels the vapor of the cooling liquid into said condenser, said last means discharging the vapor of the denser liquid into said condenser, a discharge conduit from said condenser to said boiler, said conduit having an upright portion in which the denser liquid collects at the bottom with the cooling liquid thereabove, an outlet for the cooling liquid above the level of the denser liquid, said conduit including a reservoir in series between the condenser and boiler, a pair of elastic coils in said conduit connected respectively to the upper and lower portions of said reservoir for supporting said reservoir in vertically movable relation to said boiler, and means responsive to variations in the level of said reservoir with variations in the pressure of said boiler to automatically vary the heat supplied to said boiler.

CHARLES G. SMITH.