

May 16, 1933.

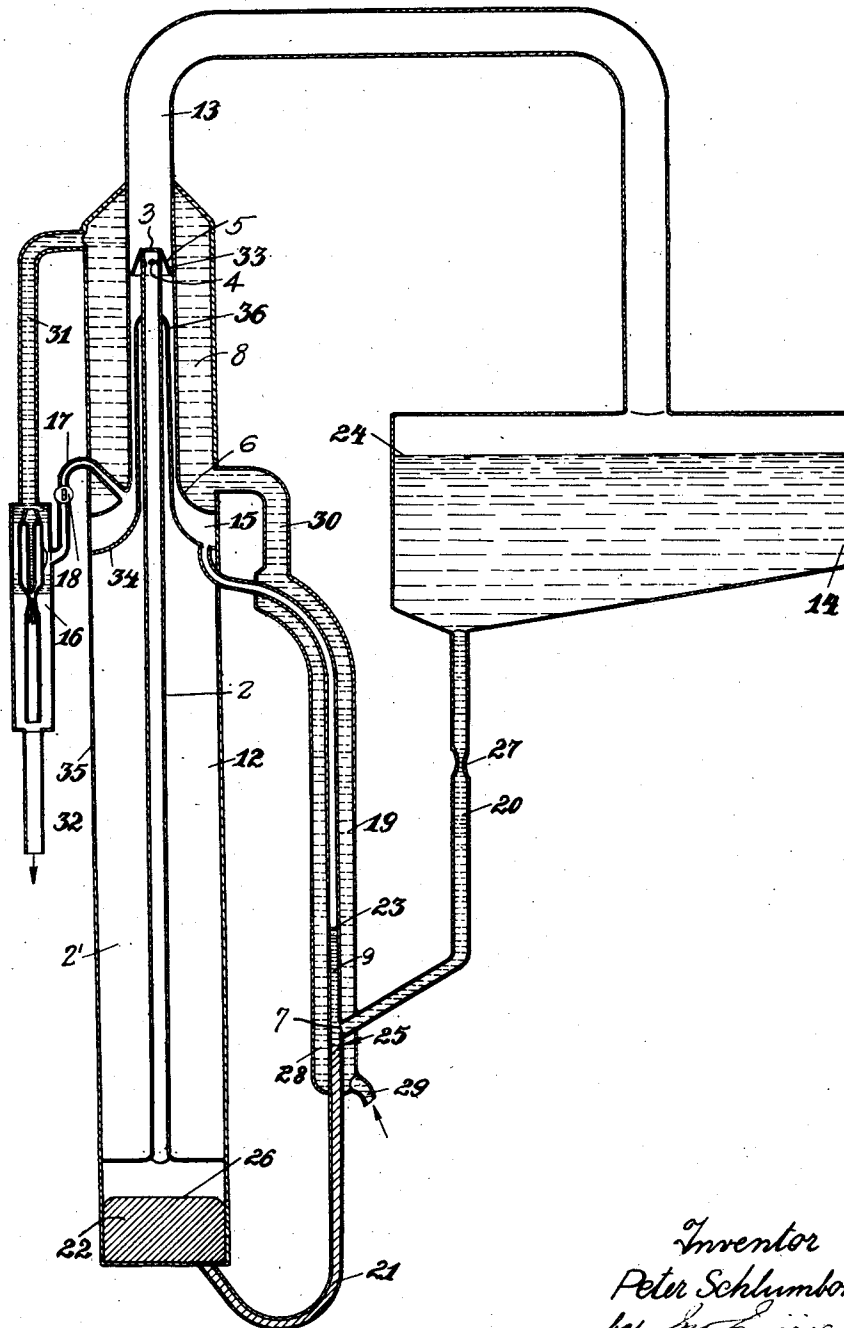
P. SCHLUMBOHM
REFRIGERATING MACHINE

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2 Sheets-Sheet 1

Fig. 1.



Inventor
Peter Schlumbecker
by No. 111111
Attorney

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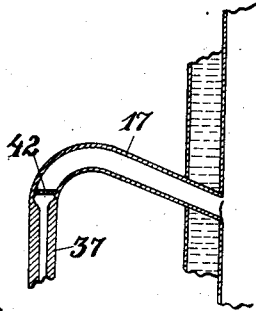


Fig. 2.

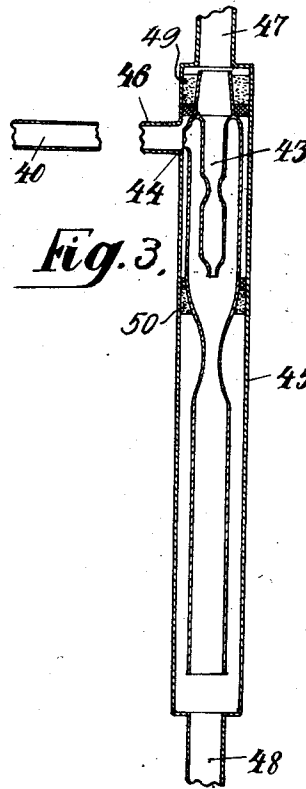
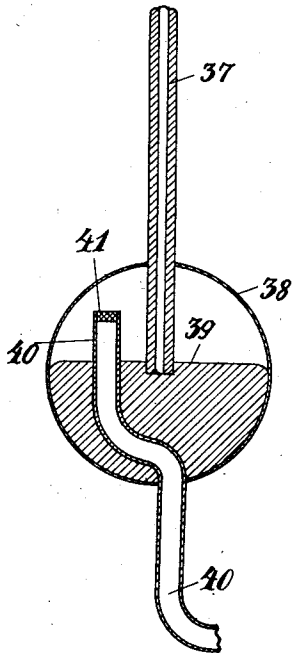


Fig. 3.

Inventor
Peter Schlumbohm
by [Signature] Attorney

UNITED STATES PATENT OFFICE

PETER SCHLUMBOHM, OF BERLIN, GERMANY, ASSIGNOR TO THE AMERICAN THERMOS BOTTLE COMPANY, OF NORWICH, CONNECTICUT, A CORPORATION OF OHIO

REFRIGERATING MACHINE

Application filed October 20, 1928, Serial No. 313,746, and in Germany October 21, 1927.

My invention relates to refrigerating machines of the type utilizing the evaporation of a liquid to produce low temperature, and its object is to provide a small compact machine adapted to operate efficiently at low cost.

According to the present invention, a tank containing a suitable liquid to be evaporated is connected with a mercury-vapor ejecting pump. The air and vapor molecules in the tank are entrained by the mercury vapor, and this gaseous mixture enters a condenser. A return pipe connects the condenser with the mercury-vapor pump, and another pipe leads from the mercury return pipe to the bottom of the tank. The condensed mercury vapors pass from the condenser to the pump through the return pipe in a continuous cycle. The condensed vapors from the tank flow down the mercury return pipe to a point where the latter connects with the tank return pipe, through which the condensate returns to the tank. The level of condensed mercury in the return pipe is below the point where that pipe connects with the tank return pipe, so that the latter is always open to the condensed cooling vapors.

There is thus provided a continuous cycle of evaporation and return of condensed vapors to the refrigerating tank, whereby a substantially constant level of the cooling liquid is maintained. In other words, the cooling medium requires no renewal, and the same is true of the mercury in the pump, so that the machine, when once started, needs no attention. To facilitate starting of the mercury vapor pump, I connect the condenser with an aspirator or similar device adapted to reduce the vapor pressure in the passage between the cooling tank and the condenser. This aspirator or ejector produces a suction pressure of about 12 mm. The low pressures at which my refrigerating machine operates constitute one of the main practical advantages of my invention, as will be clear from a detailed description of the accompanying drawings in which—

Fig. 1 shows in sectional diagrammatic form a preferred embodiment of my invention;

Fig. 2 illustrates in section a mercury seal that may be used in the apparatus of Fig. 1; and

Fig. 3 is an enlarged section of a preferred form of ejector or aspirator that may be inserted into the machine shown in Fig. 1.

A mercury boiler indicated as a whole by 12 contains a quantity of mercury 22 at the bottom, and is adapted to be heated in any practical way to vaporize the mercury. A narrow tube 2 in boiler 12 is open at the bottom and closed at the top 3, except for small holes 4 in the side wall. A cone-shaped deflector or vane 33 projects from the closed top of tube 2 into close proximity to a pipe 13 which surrounds the upper portion of tube 2. The cone 33 forms with the adjacent wall of pipe 13 a narrow circular channel 5 which forms a nozzle for the passage of air and vapor from a tank 14, with which the pipe 13 is connected. The tank 14 contains a liquid easy to evaporate, and constitutes a refrigerating unit adapted to be placed in a chamber which is to be kept cool. The liquid in tank 14 will usually be water, although other substances with low vapor pressure may be employed,—such as pyridine, octane, and the like.

The upper portion of the mercury vapor pipe 2 is provided with a jacket 34, which is connected at its lower end to the cylindrical wall of the boiler 12, and the upper end of the jacket is attached at 36 to pipe 2 a short distance below the holes 33. The pipe 13 terminates at its lower end in a flaring wall 6, which is attached to boiler 12 above the lower end of jacket 34. The separated flaring members 6 and 34 thus form a space 15 which operates as a condenser and will hereinafter be designated as such. The space 2' around pipe 2 may be evacuated to avoid the exchange of heat between that pipe and the condenser 15. A return pipe 19 leads from the bottom of condenser 15 to the bottom of boiler 12 for the return of condensed mercury vapors to the source of supply 22. The lower portion 21 of return pipe 19 preferably extends below the mercury supply 22, and this pipe should be of the narrowest possible cross-section on account of the heat-conductivity of mercury.

A second return pipe 20 leads from the bottom of tank 14 to pipe 19, with which the pipe 20 connects at 7.

The closed annular space 8 in the upper portion of mercury boiler 12 constitutes a water jacket for keeping the condenser 15 cool. A water-inlet pipe 30 communicates with the lower end of water jacket 8, and an outlet pipe 31 leads from the upper end of the jacket. The inlet pipe 30 forms a water jacket 28, through which the major length of return pipe 19 passes. The cooling liquid enters jacket 28 at the bottom through pipe 29 and flows upward through the cooling jackets 28 and 8. The outlet pipe 31 connects with the upper end of an aspirator or ejector indicated as a whole by 16, and a narrow pipe 17 connects this ejector with the upper wall of condenser 15. If desired, a cock or valve 18 may be included in pipe 17 to control the connection between condenser 15 and ejector 16. An outlet pipe 32 is connected to the lower end of the ejector. The purpose of ejector 16 is to withdraw air molecules from condenser 15, whereby the proper degree of vacuum or under-pressure is maintained in pipe 13 during the operation of the machine, as will presently be explained.

The above described apparatus operates like this: As the mercury 22 boils, the vapor passes up the pipe 2 and out through the small holes 3 at the top into condenser 15. The suction created by the high-speed downward passage of mercury vapor when deflected by vane 33 draws vapor and air molecules from tank 14 through the narrow circular nozzle 5, thereby reducing the vapor pressure in tank 14 and lowering the temperature of the liquid in the tank. Thus, a mixture of mercury vapor, vapor from the liquid in tank 14, and air molecules that were present in the tank and pipe 13, passes down into the condenser 15. The suction action of aspirator 16 withdraws the air entrained by the mercury vapor, and the condensed vapors flow out of condenser 15 through pipe 19. The mercury portion of this mixture of condensed vapors passes through pipe 19 back to the original supply 22. The condensed vapors that came from tank 14 are lighter than the mercury vapor and therefore float on top of the mercury. As shown in Fig. 1, the mercury level 25 is below the connection 7 of pipe 20 with pipe 19, so that the column of condensed vapors 9 is open to tank 14 through pipe 20. The level of column 9 is indicated at 23. By extending the lower portion 21 of return pipe 19 sufficiently below the level 26 of the mercury in boiler 12, the liquid column 9 and the connected column in pipe 20 find a sufficient counterweight of mercury to prevent the liquid of those columns from entering the mercury boiler 12. The lower U-shaped portion of return pipe 21 always contains mercury, and before the operation of the pump the mer-

cury levels 25 and 26 are nearly equal. The difference in height between these levels during the operation of the pump depends upon the difference of pressure in the boiler and in the evaporator. A restriction 27 in pipe 20, or a similar resistance means, helps to prevent undue fluctuations of the liquid column connected with pipe 20 when the machine is started.

During the operation of the machine, the pressure in condenser 15 is less than one millimeter, and the suction obtained by the aspirator 16 is about twelve millimeters, which also represents the head between levels 24 and 25. Before starting the mercury cycle, the aspirator 16 should first be operated to reduce the vapor pressure in pipe 13, so that the mercury vapor pump may properly function. Since the vapors of mercury 22 in boiler 12 and of the evaporating liquid in cooling tank 14 are condensed and returned to their respective sources, the levels 26 and 24 remain practically constant and the machine thus becomes a complete self-contained refrigerating unit.

Instead of using the manually operated valve 18 in pipe 17 to start and stop the aspirator 16, I may use the automatic arrangement illustrated in Fig. 2. Here the pipe 17 contains a capillary tube 37 about eighty centimeters long, which is connected at its lower end with a closed receptacle 38 containing mercury 39. The tube 37 dips slightly below the level of the mercury, which fills the receptacle about half. A pipe 40, connected to the suction pipe of an ejector 45 (see Fig. 3), also extends into receptacle 38 but several centimeters above the mercury level. The upper end of pipe 40 is provided with a mercury filter 41, and a similar filter 42 is mounted at the upper end of the capillary tube 37. The ejector 45 preferably comprises an outer metal tube containing a core 43 of glass, porcelain, or similar material, capable of withstanding the constant flow of cooling water. The core 43 is cemented in the metal tube 45 above and below the suction opening 44, the cement being indicated at 49 and 50. The pipe 40 is connected to suction pipe 46, and the upper end of core 43 communicates with a water-inlet pipe 47. The lower end of metal tube 45 is open to a water-outlet pipe 48.

Assuming the ejector 45 to be in operation, a suction is created in pipe 40. Should the vacuum in the machine decrease below a predetermined point, and should the pressure in condenser 15 exceed a certain amount, the mercury seal of suction pipe 40 in receptacle 38 is automatically broken and the ejector action stops. The air now entering the receptacle 38 through pipe 40 forces the mercury into the capillary tube 37, in which a mercury column is produced with a pressure corresponding to the pressure in condenser 15. This mercury column prevents the entrance of

air into the machine as long as the ejector action stops.

I may add that, in the practical operation of the machine, the cooling water will have a temperature of 20° C. This means that the mercury is conducted back to the boiler at about that temperature, so that it now has to be heated from 20° C. to the boiling point. The latter depends upon the pressure in front of ejector nozzle 5. By way of example, it may be mentioned that with 440 mms. the mercury boils at 328° C.; with 100 mms. at 261° C.; and with 50 mms. at 235° C. The pressure existing in condenser 15 corresponds to the saturation pressure of the cooling means at a temperature of about 20° C. This saturation pressure is 17 mms. for water and 10 mms. for octane. The saturation pressure of mercury at 20° C. is practically zero.

It will be clear from the preceding description that I have provided a small self-contained refrigerating machine especially adapted for household use, one that operates reliably and at a low cost. Since the machine utilizes mercury vapor of low temperature, there is no danger of decomposition of the cooling liquid in tank 14. Also, the use of cooling means with low vapor pressure requires a small amount of heat to produce the necessary quantity of mercury vapor.

Although I have shown and described a specific form of apparatus, changes and modifications may be made without departing from the scope of the invention as defined in the appended claims.

I claim:

1. A refrigerating system including a refrigerant pump using mercury vapor as a propellant fluid, an evaporator connected to the suction of the pump, a condenser receiving the discharge from the pump, and an ejector actuated by the condenser water for removing uncondensable gases from the system.

2. The structure as defined in claim 1, in which the suction of the ejector is connected to the condenser.

3. The structure as defined in claim 1, including a mercury seal in the suction conduit of the injector, whereby in the interruption of the injector the condenser is closed against atmospheric pressure.

4. The structure as defined in claim 1, including a nozzle system in which said injector is constructed of a glass-like substance.

5. In combination with a refrigeration system including a water cooled condenser, an ejector for removing uncondensable gases from said system, said ejector comprising a metal tube having a water inlet at one end and a water outlet at the other end, a suction pipe connected to said tube near the water inlet, an ejector tube of glass-like material

fixed within said metal tube and forming an airtight joint therewith above and below said suction pipe, said ejector tube having an inlet communicating with said suction pipe, and a nozzle forming part of said ejector tube and extending downwardly therein, said nozzle being open to the water inlet of said metal tube.

In testimony whereof I affix my signature.

PETER SCHLUMBOHM.

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