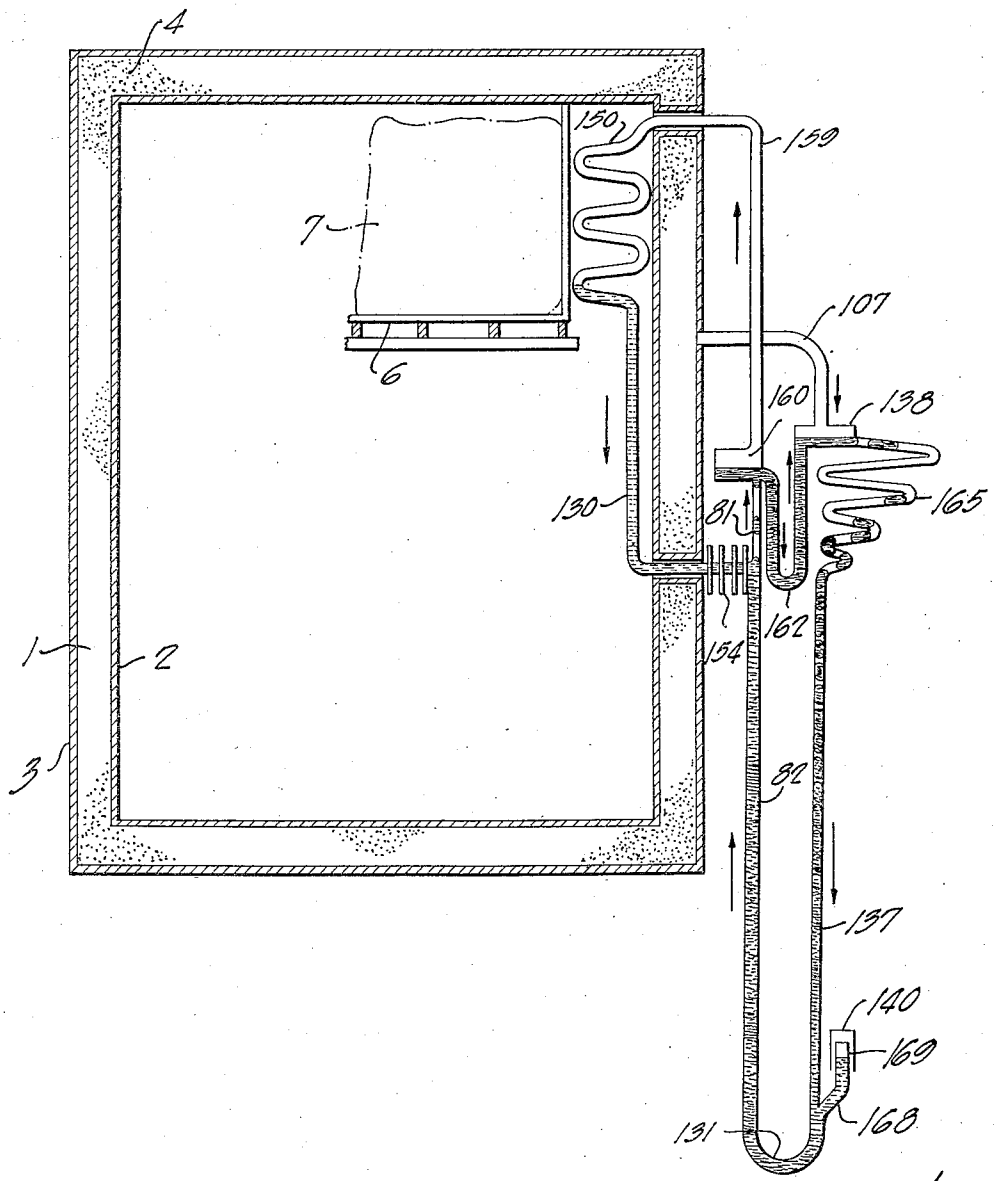
Feb. 21, 1933. D. F. COMSTOCK 1,898,172

VACUUM INSULATION

Original Filed Sept. 7, 1928



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UNITED STATES PATENT OFFICE

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VACUUM INSULATION

Original application filed September 7, 1928, Serial No. 304,589. Divided and this application filed March 30, 1932. Serial No. 602,008.

This invention relates to insulation as employed for refrigerator cars, refrigerant ducts, hot or cold fluid pipes or tanks, heaters, boilers, houses or other installations, and more particularly as associated with the former. This application is a division of my copending application Serial No. 304,589, filed September 7, 1928.

While it has heretofore been proposed to utilize vacuum chambers for insulating refrigerators or the like, the difficulty of permanently maintaining a comparatively high vacuum in housing of this character has made the commercial provision of such insulating means impractical. There have been certain arrangements proposed for associating a vacuum pump, for example, of the piston type, with a refrigerating machine to maintain a vacuum in a hollow refrigerator housing. However, such an arrangement does not assure the maintenance of a high vacuum, while necessitating the provision of a refrigerating unit of special design.

The present invention more particularly affords an arrangement permitting the automatic maintenance of a relatively high vacuum due to temperature differences existing at opposite sides of the insulating wall.

This invention particularly permits the employment of vacuum insulation even if a perfectly vacuum-tight wall is not provided, due to the automatic pumping of gas from the wall by means of a system operable in response to energy which is a characteristic of the temperature difference existing at opposite sides of the insulating wall. Thus, for example, this invention is particularly applicable to a refrigerator employing ice or employing any desired refrigerating unit without requiring the employment of a particular form of cooling means.

It is extremely difficult to provide absolutely air- or gas-tight housings of considerable size in commercial quantities, especially when these vacuum containers are partially formed of metal sheets with soldered and/or welded joints or seams. It is feasible, however, to provide vacuum insulating chambers of this character which under ordinary conditions of use have only a low rate of gas leakage. I therefore provide pumping means which need not have high volumetric capacity and which does not require a large expenditure of energy. Such pumping means may be continuously operable as long as a substantial temperature differential exists between opposite sides of the insulating wall. The pumping means may have portions at opposite sides of the insulating wall and may include a fluid circuit arranged so that a circulating fluid passes from a region of high pressure to a region of low pressure, while entraining a second fluid, a portion of the latter being arranged to entrain gas from the insulating wall and to exhaust the same to the atmosphere or any suitable receiving receptacle.

In the accompanying drawing the figure is a more or less diagrammatic view showing a vacuum housing provided with an automatically operable pumping means associated with a refrigerator which may employ ice as a cooling medium.

In the accompanying drawing, the refrigerator housing 1 may be of any suitable type to provide inner and outer walls 2 and 3, respectively, with a vacuum chamber therebetween. This vacuum chamber may contain powdered or foraminous insulating material such, for example, as diatomaceous earth, if desired. In general, the structural details of such a refrigerating housing are more fully illustrated in my above-identified copending application, and in my copending application Serial No. 437,377, filed March 20, 1930. The housing 1 may contain any suitable cooling means such as a mechanical cooling unit or, for example, may be provided with a bunker shelf 6 to receive a piece of ice 7, indicated by dot and dash lines.

In accordance with this invention, a condenser 150 in the form of a pipe coil may be located within the refrigerator adjoining the cooling medium 7, the upper end of this condenser being connected by the duct 159 with a separating chamber 160 disposed at the exterior of the housing 1. The lower end of the condenser may be connected by a duct 130 to a vaporizer 154 that is also located upon the exterior of the housing 1. The opposite

end of vaporizer 154 is connected to the lower end of a capillary tube 81, this tube having a restricted internal diameter so that globules of a circulating liquid, such as mercury, may flow therethrough in the form of separate liquid pistons. The tube 81 is continued downwardly below the vaporizer 154 to afford an extension 82 which may be non-capillary, if desired, and may be provided with a U-shaped lower end or trap 131. The other leg 137 of this trap communicates through a branch 168 with a receptacle 169 having an open upper end which may be protected by a cover 140.

The upper end of capillary tube 81 communicates with the bottom of separating chamber 160 which is connected through a trap 162 with a chamber 138. The latter is connected to a pipe 107 which communicates with the interior of casing 1 and with a downwardly extending sinuous or coiled pipe 165 of restricted internal diameter. The latter extends first in a generally sinuous or helical form with convolutions or runs of decreasing size until it joins the upper end of the leg 137 to trap 131 to which branch 168 is connected.

The lower part of the system just described may be filled with a suitable relatively heavy and non-volatile liquid, such as mercury, which occupies the legs 82 and 137 of trap 131 and which also occupies trap 162. Above the mercury or similar non-volatile fluid I may provide a body of fluid which vaporizes under the temperature conditions normally existing upon the exterior of housing 1, but which condenses under the temperature conditions normally existing within that housing.

In the operation of apparatus of this character when a suitable temperature differential exists between opposite sides of the insulating wall, the vaporizer 154 is effective, due to the heat of the surrounding air, in causing vaporization of the more volatile fluid which tends to rise to the capillary tube 81, lifting globules of mercury from the upper end of duct 82 to the separating chamber 160, from which the mercury drains into the adjoining leg of trap 162, while the vapor rises through the duct 159 and is received by the condenser 150. The latter is at a temperature which is low enough to result in the condensation of the more volatile fluid which collects in its liquefied phase in the duct 130, thus forming a pressure balancing column which counteracts the pressure within vaporizer 154. Mercury from trap 162 overflows into chamber 138 due to additional increments of mercury received from the chamber 160 and due to the vapor pressure acting upon the mercury at this point. From the chamber 138 successive globules pass downwardly through the sinuous pipe 165 entraining bodies of rarefied gas from the pipe 107 which is connected to the housing 1. The successive bodies of gas which are thus entrained are compressed between mercury globules as the latter flow downwardly in pipe 132 so that small gas bubbles separate from the mercury at the juncture of pipes 137 and 168 and rise to the open-topped receptacle 169, thence passing into the atmosphere. It is evident that the mercury within the chamber 137 plus the slight pressure thereabove is effective in counter-balancing the atmospheric pressure upon the mercury in receptacle 169.

I claim:

1. The combination of a heat insulating wall including a vacuum chamber and pumping means for maintaining a vacuum within the chamber, said pumping means being operable in response to the difference in temperatures existing at opposite sides of the wall.

2. The combination of a heat insulating wall including a vacuum chamber and pumping means for maintaining a vacuum within the chamber, said pumping means comprising a fluid duct having portions at either side of the wall and causing movement of fluid therethrough in response to different temperatures existing at opposite sides of the wall.

3. The method of maintaining a vacuum in a chamber of an insulating wall and of compensating for leaks in the same, which comprises establishing a temperature differential at opposite sides of the wall, circulating fluid from one side of the wall to the other, the pressure in the fluid circuit permitting vaporization of the fluid at one side of the wall and condensation at the other, utilizing the vaporized fluid to draw gas from the chamber and exhausting the same from the fluid circuit.

4. In combination a heat insulating wall including a vacuum chamber, means operable in response to a temperature difference between opposite sides of said wall to maintain a vacuum in the chamber, said means comprising a fluid circuit having portions at each side of the wall and having a pressure therein permitting the vaporization of the contained fluid at the hot side of the wall and condensation at the cold side thereof, a liquid circuit having a part in common with the fluid circuit, whereby liquid is entrained by vapor circulating in the first circuit, said liquid circuit having a gas entraining portion of restricted diameter spaced from the aforesaid common portion, a gas inlet and a gas outlet to said entraining portion, the inlet being connected to the vacuum chamber whereby gas may be entrained and compressed between liquid globules in said portion.

5. In combination a heat insulating wall including a vacuum chamber, means operable in response to a temperature difference between opposite sides of said wall to maintain a vacuum in the chamber, said means com-

prising a fluid circuit having portions at each side of the wall and having a pressure therein permitting the vaporization of the contained fluid at the hot side of the wall and condensation at the cold side thereof, a liquid circuit having a part in common with the fluid circuit whereby liquid is entrained by vapor circulating in the first circuit, said liquid circuit having a gas entraining portion of restricted diameter spaced from the aforesaid common portion, a gas inlet and a gas outlet to said entraining portion, the inlet being connected to the vacuum chamber, said restricted portion having a gradual downward inclination adjoining the gas inlet whereby a large volume of gas may be entrained between successive liquid globules.

6. The combination of a heat insulating wall including a vacuum chamber and pumping means for maintaining a vacuum within the chamber, said pumping means comprising a fluid duct having portions in heat conductive relation with regions at opposite sides of the wall and arranged to cause fluid movement due to the different temperatures existing in said regions.

Signed by me at Boston, Massachusetts, this 23rd day of March, 1932.

DANIEL F. COMSTOCK.