Dec. 8, 1942. E. P. ARTHUR 2,304,757

REFRIGERATOR CONSTRUCTION

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Fig. 1.

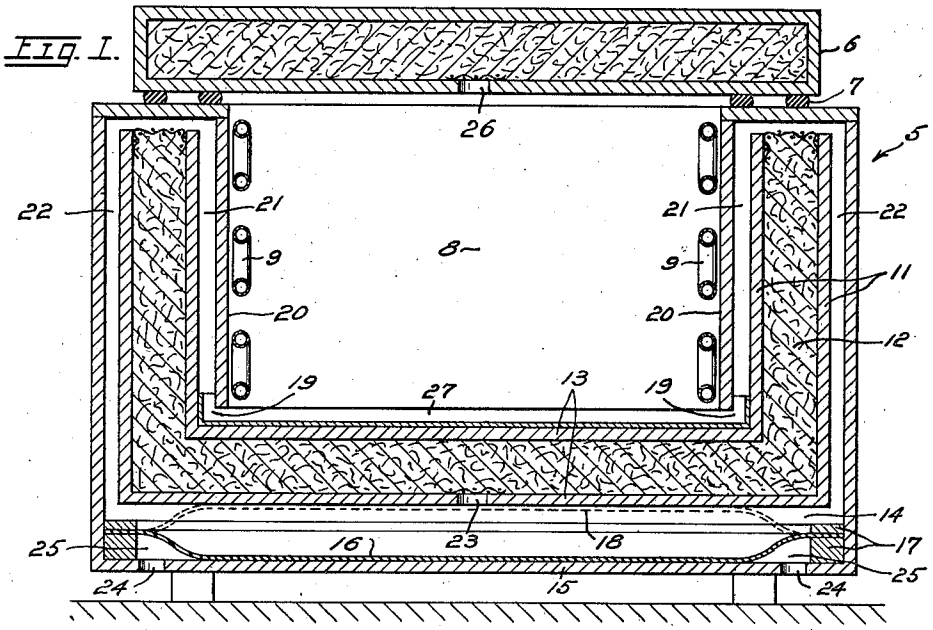
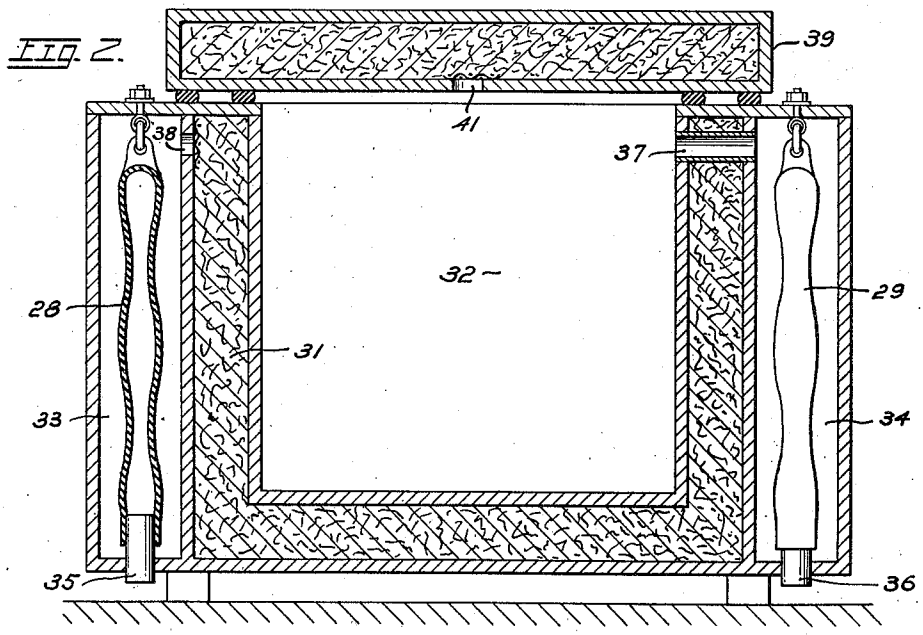


Fig. 2.



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REFRIGERATOR CONSTRUCTION

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2 Claims. (Cl. 220—14)

My invention relates to refrigerator constructions, and particularly to such of them as are adapted for operating at temperatures well below the freezing point of water. Its objects include; first, to achieve thermal insulation means which are more effective, and more easily maintainable at high efficiency, than those now available; second, to provide against progressive degeneration of thermal insulation by the phenomenon known as water-logging; third, to secure the integrity of flat refrigerator wall structures indefinitely, by freeing them from the effects of transverse unbalanced pressures resulting from variations in temperature; and, fourth, to accomplish all of these things by means of simple, dependable, and relatively inexpensive construction.

I attain my objects in the manner illustrated in the accompanying drawing, in which—

Figure 1 is a central vertical section of a refrigerator which embodies a specific form of my invention; and Figure 2 is a similar section of another specific form of my refrigerator construction. The first figure represents a structure which primarily is intended for cooling, but which also is adapted for cold storage. The second figure represents a structure which primarily is intended for cold storage; but which may be used for cooling by employing "dry ice" or the like, as the cooling medium.

The figures of the drawing are largely diagrammatic, and not strictly pictorial. Similar reference numerals refer to similar things throughout both of them.

Temperature variations in closed heat-insulated spaces, produce corresponding changes of pressure. In sub-freezing service, the temperature variations may be 100° F. or more; and the resulting pressure differentials, with respect to cooperating closed spaces and the surrounding atmosphere, may be relatively great. Unless they are adequately provided against, these unbalanced pressures certainly will cause more or less rapid and progressive deterioration of both thermal insulation and structural integrity. The reasons will be explained briefly below.

When a refrigerated space is cooled to the extent indicated above; the walls thereof, and everything therein, ultimately will reach dew point temperature. If water vapor is present, condensation then will take place upon said walls and contents; and it will be accompanied by the partial vacuum which is the prime cause of most refrigerator troubles.

The effectiveness of thermal insulation depends chiefly upon maintaining dry air in its interstitial spaces. Water, which is a relatively good conductor of heat, will destroy it. Although the amount of condensation in the cold interstitial spaces may be very little during any one cycle of operation; the accumulated effects over a period of time, if small amounts of moisture-laden air are continually permitted to infiltrate, will destroy the insulation. Each increment of moisture will condense, and add an increment to the vacuum. That increase will cause still more moisture-laden air to be drawn in, and a still higher vacuum will result. In time, the entire interstitial space will become filled with water of condensation, and the refrigerator be rendered worthless. That condition is known as "water-logging." Long before it becomes complete, it makes the cost of operating the refrigerator very excessive.

Structurally, the vacuum caused by condensation in refrigerated spaces tends to exert destructive effects, because of the cyclic pressure differentials which accompany it. Refrigerators commonly are constructed with flat walls of thin sheet material, and unbalanced lateral pressures against them may impose stresses which they cannot resist without undue stresses and deformation. The resulting periodic deflections are known as "breathing"; and, eventually, cracks and joint leakage will develop in consequence of this action. Air, with its usual moisture burden, will then be able to flow through the cracks, from spaces of higher, to spaces of lower pressure; and the insulation gradually will become water-logged and worthless.

"Breathing," however, is the natural automatic way for equalizing pressures on the opposite sides of thin flat walls; and such pressures must be automatically equalized in refrigerators, if air leakage, with its attendant ills, is to be permanently avoided. My construction provides adequate means for permitting air tight spaces to effectively breathe, without deleterious consequences.

The embodiment illustrated in Fig. 1 consists of a rectangular refrigerating cabinet 5, which normally is closed by its cover 6. The closure is made air-tight by means of suitable gaskets 7, of which there may be an inner and an outer ring as shown. Cooling of the refrigerating space 8 is accomplished in the ordinary way, by means of pipe-coils 9.

The side walls of this cabinet each have four spaced panels. Of these, the inner pair 11 are more widely spaced than the others, and have approved thermal insulating material, such as a

mass 12 of glass wool, between them. The bottom of the cabinet essentially is tripartite, with the space between the upper pair 13 of its panels filled by a continuity of the same body of glass wool. In a deep space 14, above bottom panel 15, there is a large flexible diaphragm 16, of rubber or like material. This is disposed horizontally, and its periphery is tightly sealed to the wall of space 14, as by means of the blocks at 17. This periphery is located about half way between the upper and lower limits of space 14; so that the diaphragm may either lie flat upon panel 15; or be deflected upwardly by pneumatic pressure against the under-side of the lowermost panel 13 as indicated by dotted lines 18.

Refrigerating space 8 communicates with that part of space 14 which is above the horizontal diaphragm; by passages 19 around the bottom edges of inner side panels 20, and by inter-panel passages 21 and 22. The mass of glass wool is highly permeable, and its interstitial spaces communicate with space 14 in the same way; and additionally by means of an orifice 23 in the lowermost of the paired bottom panels 13. Panel 15 has one or more orifices 24 therethrough; to vent the space 25 below the diaphragm, to atmosphere.

Cover 6 is hollow and filled with glass wool, as indicated; and its interior is vented into refrigerating space 8, by means of an orifice 26.

A metal pan 27 may be employed at the bottom of refrigerated space 8, if thought desirable, but it plays no part in the thermal operation of the device.

It will be seen that, when cover 6 is closed against its gaskets; refrigerating space 8, and all its connections including the spaces occupied by the thermal insulating material, is wholly sealed from the atmosphere. No moisture-laden air can penetrate thereinto. Nevertheless the effective volume in these spaces varies according to the degree of vacuum that exists therein. Thus, as the pressure within space 8 tends to become sub-atmospheric, by reason of temperature reduction; diaphragm 16 rises under the pressure exerted by the outside atmosphere, to reduce the volume of the enclosed spaces sufficiently to neutralize the pressure differential. The entire action is automatic, instantaneous, and wholly effective within the proper operating range for which the device is designed. All of the advantages of "breathing" may be secured in this way, without the hitherto invariable accompaniment of deleterious air infiltration. During the brief times when the cover of the cabinet is open, no moisture-laden air can enter the interstitial spaces of the thermal insulation; because all of its moisture will be deposited upon cooling coils 9 as a result of the lower temperature and lower vapor pressure thereat. All air within the closed cabinet, even if it should happen to carry water vapor initially, will gradually become dry for this reason.

In the embodiment illustrated in Fig. 2, the functioning is closely similar to that described. Here, however; no cooling coils are used; suspended flexible diaphragms, comprising the walls of two closed bags 28 and 29, of rubber or like material, have been substituted for horizontal diaphragm 16; and the interstitial spaces of the main body 31 of insulating material, do not communicate with cold storage space 32. Bags 28 and 29 are located respectively in closed chambers 33 and 34, into which they may expand. The interiors of the bags communicate only with the atmosphere, through tightly fitted nozzles 35 and 36. Cold storage space 32 communicates with chamber 34, through a tube 37, and the interstitial spaces of the main body of insulating material communicate only with closed space 33, through an orifice 38. Cover 39 also is filled with insulating material, and it has an orifice 41 through its bottom panel, by means of which the interstitial spaces of the cover insulation are in communication with cold storage space 32.

It will be apparent from the foregoing description; that, within the limits of their designs, there can be no material departure from atmospheric pressure in any of the spaces within the constructions, notwithstanding great differences in temperature between the inside and outside; and that moisture laden air cannot enter the interstitial spaces of the insulation when the devices are properly operated. Obviously, therefore, the useful life of my constructions will be much greater than that of the comparable constructions known hitherto.

Various departures in the choice of materials, proportions of parts, configuration of the elements, and arrangement of the parts; are contemplated by me to meet special requirements. Such things are matters of design only, and are within the capacity of those skilled in the art.

I claim as my invention:

1. Refrigerator construction comprising; a refrigerator chamber having two spaced-apart walls therearound; a hollow box-like closure for the chamber affording access thereto; a diaphragm compartment communicating only with the space between said walls; another diaphragm compartment communicating only with the refrigerator chamber; a vertically disposed and horizontally distensible impervious diaphragm, in the form of a bag of rubber-like material, in each of said compartments; tight tubular passages leading from the interiors of the bags to the outer atmosphere; permeable thermal insulation confined by said two walls; and similar insulation filling the hollow of said closure; said hollow being in communication with said chamber when the latter is closed.

2. Refrigerator construction comprising; a refrigerator chamber having two impervious spaced-apart walls therearound; a hollow box-like structure adapted for closing the chamber and affording access thereto; a diaphragm compartment communicating only with the space between said walls; another diaphragm compartment communicating only with the refrigerator chamber; a diaphragm in the form of a distensible bag of impervious rubber-like material in each of said compartments; tight tubular passages leading from the interiors of the bags to the outer atmosphere; a continuous mass of permeable thermal insulation confined by said two walls; another mass of thermal insulation filling the hollow within said box-like structure; said hollow being in communication with said refrigerator chamber when the box-like structure is in its closed position; and said bags being vertically disposed and in normal operation of the refrigerator, being adapted by horizontal distension and collapsing to prevent substantial differences of pressure respecting their insides and outsides.

EDWIN P. ARTHUR.