June 7, 1960 E. F. DILLON 2,939,811

HEAT-INSULATING UNITS FOR REFRIGERATOR CABINETS

Filed March 25, 1957

Fig. 1

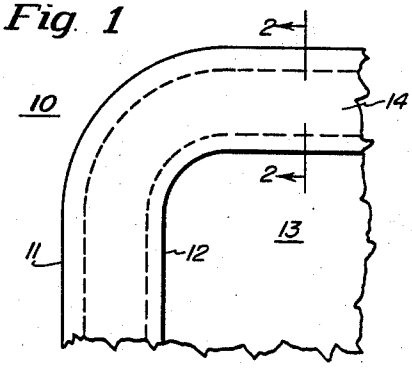


Fig. 2

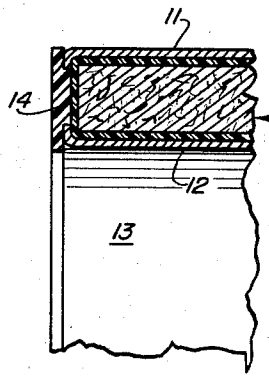


Fig. 3

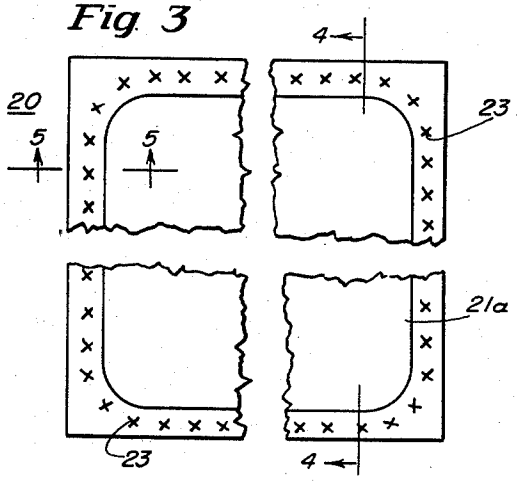


Fig. 4

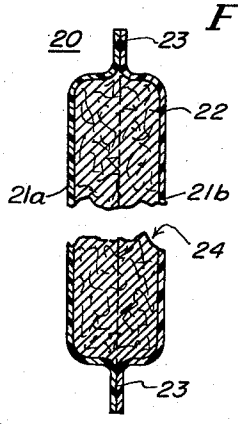
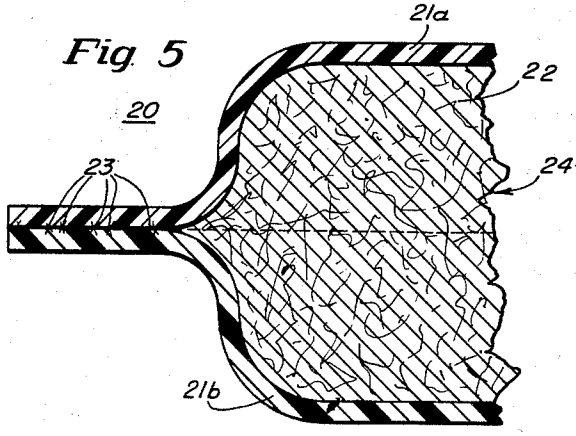


Fig. 5



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HEAT-INSULATING UNITS FOR REFRIGERATOR CABINETS

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3 Claims. (Cl. 154—45)

The present invention relates to heat-insulating units for refrigerator cabinets, or the like.

It is a general object of the invention to provide a heat-insulating unit of deformable pillow-like construction and adapted to be conformed to the space disposed between the inner and outer metal walls of a refrigerator cabinet, or the like, wherein the unit is of improved construction and arrangement including an hermetically sealed bag having deformable sheet-like walls of low thermal conductivity that are highly impervious to gas and containing both a deformable mass of porous solid heat-insulating material and a charge of gas at substantially atmospheric pressure, and wherein the charge of gas has a thermal conductivity lower than that of air and essentially comprises a mixture of carbon dioxide and dichloride-difluoromethane.

Another object of the invention is to provide an improved heat-insulating unit of the character described, wherein the charge of gas mentioned essentially comprises by weight about 15 to 25 parts carbon dioxide and about 75 to 85 parts dichloro-difluoromethane.

Further features of the invention pertain to the particular arrangement of the elements of the heat-insulating unit, whereby the above-outlined and additional operating features thereof are attained.

The invention, both as to its organization and principle of operation, together with further objects and advantages thereof will best be understood by reference to the following specification taken in connection with the accompanying drawing, in which:

Figure 1 is a fragmentary front view of the upper left-hand portion of a household refrigerator cabinet incorporating a heat-insulating unit embodying the present invention;

Figure 2 is a fragmentary vertical sectional view of the refrigerator cabinet, taken in the direction of the arrows along the line 2—2 in Fig. 1;

Fig. 3 is a fragmentary plan view of a heat-insulating unit incorporated in the refrigerator cabinet shown in Figs. 1 and 2;

Fig. 4 is a fragmentary vertical sectional view of the heat-insulating unit, taken in the direction of the arrows along the line 4—4 in Fig. 3; and

Fig. 5 is a greatly enlarged fragmentary horizontal sectional view of the heat-insulating unit, taken in the direction of the arrows along the line 5—5 in Fig. 3.

Referring now to Figs. 1 and 2 of the drawing, there is illustrated a cabinet 10 for a household refrigerator, or the like, embodying the features of the present invention and comprising a metal outer shell 11 and a metal inner liner 12, both of box-like form, the metal inner liner 12 being arranged in nested relation within the metal outer shell 11. The cabinet 10 comprises a portion of a household refrigerator, as previously noted, and cooperates with a refrigerating machine, not shown, that includes a refrigerant evaporator that is operatively associated with a food storage space 13 defined within the inner liner 12. For example, the refrigerant evaporator may be

arranged in any suitable manner within the storage space 13 for the purpose of effecting the required cooling of the food, or the like, stored therein. A substantially rectangular heat-insulating frame strip 14, usually formed of a suitable molded plastic material, is arranged about the open front of the cabinet 10 and joining the boundary edges of the outer shell 11 and the inner liner 12. As shown in Fig. 2, the boundary edges of the walls of the outer shell 11 may be provided with inturned flanges and the boundary edges of the walls of the inner liner 12 may be provided with outturned flanges, which flanges are joined together by the frame strip 14 in order to close the space between the shell 11 and the liner 12, the securing means for the frame strip 14 being entirely conventional.

Arranged within the space defined between the outer shell 11 and the inner liner 12 are a number of heat-insulating units 20 of pillow-like construction; which heating units 20 are designed nicely to fit between the outer shell 11 and the inner liner 12 and substantially completely to fill up the space disposed between the elements 11 and 12. For example, the space between the outer shell 11 and the inner liner 12 may be nicely filled by a pair of cooperating and differently constructed ones of the heat-insulating units 20, a first of these heat-insulating units being deformed into a substantial U shape and arranged to fill the top and side portions of the space noted, and a second of these heat-insulating units being deformed into a substantial L shape and arranged to fill the bottom and rear portions of the space noted.

Referring now to Figs. 3 to 5, inclusive, of the drawing, the heat-insulating unit 20 there illustrated is of substantially pillow-like form and of substantially rectangular configuration; the unit 20 comprising a pair of complementary sheets 21*a* and 21*b* disposed on opposite sides of a bat or mattress 22 of heat-insulating material; which sheets 21*a* and 21*b* are drawn down snugly around the mattress 22 and sealed about the meeting marginal edges thereof, as indicated at 23, thereby to define an hermetically sealed bag confining the mattress 22. Accordingly, the hermetically sealed envelope or bag of the unit 20 comprises the two complementary sections of substantially rectangular dish-like configuration and including the pair of opposed facing walls respectively defined by the pair of sections and the connecting marginal wall jointly defined by the pair of sections.

In the arrangement, the sheets 21*a* and 21*b* are formed of deformable sheet-like synthetic plastic material of low thermal conductivity and preferably of the synthetic organic resin known as "Saran," essentially including polymers of vinylidene chloride. This material is particularly recommended because of its resistance to passage of gas therethrough, flexibility, tensile strength, resistance to aging and resistance to chemical attack by a wide variety of chemical compounds. Other satisfactory and reasonably equivalent materials of which either or both of the individual sheets 21*a* and 21*b* may be formed are: polyvinyl chloride, vinyl-nitrile rubber, polyethylene, etc., as well as copolymers of such materials. The mattress 22 preferably comprises a deformable porous mass of solid heat-insulating material, and while it may comprise a wide variety of such materials, it preferably comprises a mass of loosely packed glass fiber, the glass fibers being suitably matted to render the bat or mattress 22 sufficiently self-supporting and integrated to accommodate ready handling thereof. Other substances which may be confined in the envelope of the unit 20 may include mineral wool, expanded slag, expanded vermiculite, etc.

Further, the bag of the unit 20 comprises a charge (indicated by the reference character 24) of gas in the

form of a mixture of carbon dioxide and dichlorodifluoromethane, and essentially comprising by weight about 15 to 25 parts carbon dioxide and about 75 to 85 parts dichloro-difluoromethane. Preferably, the mixture of the charge **24** comprises by weight about 20 parts of CO_2 and about 80 parts of CCl_2F_2. The charge **24** of gas permeates the bat **22**, whereby the mattress **22** and the charge **24** of gas cooperate to fill the hermetically sealed bag of the unit **20**. This charge **24** of gas has a thermal conductivity that is lower than that of air, as well as a boiling point that is near the lower extremity of the normal operating temperature range of the unit **20**.

It is noted that when the refrigerator cabinet **10** is employed in the storage of food in a frozen condition, the temperature of the refrigerated space **13** may be as low as −30° F., whereas, when the refrigerator cabinet is not in use and is involved in railway transportation or in warehouse storage, the temperature of the space **13** may be as high as +150° F.; whereby the charge **24** of gas confined within the bag of the unit **20** may be subjected to any temperature within the "so-called" operating temperature range extending from about −30° F. to about +150° F. Thus hereinafter the expression: "operating temperature range" of the charge **24** of gas confined within the bag of the unit **20** refers to the total temperature range to which it may be subjected and not merely to the temperature range involved in the normal operation of the refrigerator cabinet **10** in use. The walls of the bag of the unit **20** have sufficient elasticity that the normal operating pressure range of the charge **24** of gas confined therein in the normal operating temperature range thereof (−30° F. to +150° F.) does not depart materially from atmospheric pressure. Specifically, the walls of the bag of the unit **20** are capable of the necessary distention to accommodate the required expansion of the confined charge **24** of gas as the temperature thereof is increased within the normal operating temperature range of the unit **20**. Accordingly, the bag of the unit **20** is not ruptured, punctured or subjected to undue strain, within the normal operating pressure range of the confined charge **24** of gas in the normal operating temperature range thereof.

When the unit **20** is in place in the refrigerator cabinet **10**, it nicely fills the space between the cabinet walls **11** and **12**; and in placing the unit **20** in this space, it is deformed to conform to this space, the mattress **22** and the walls **21***a* and **21***b* accommodating the required deformation. In the operation of the unit **20**, the mattress **22** of glass fibers breaks up the charge **24** of gas confined in the bag thereof, so as to minimize or prevent substantial convection currents within the bag. In the construction of the unit **20**, each wall of the bag thereof is substantially impervious to the passage of air, gas, moisture, etc., therethrough, and the meeting marginal portions of the two sheets **21***a* and **21***b* may be electronically or adhesively sealed, as indicated at **23**, so as to provide a complete union between these two sheets.

Heretofore, it has been noted that the walls of the hermetically sealed bag of the unit **20** are substantially impervious to the passage of air, gas, moisture, etc., therethrough by virtue of the construction thereof; and while this statement is essentially correct, these walls necessarily have some permeability with respect to the gases involved, since these walls inherently comprise diaphragms through which there is diffusion of these gases. In other words, over an extended time interval (6 months to 2 years) the diffusions noted become readily measurable; whereby some air from the outside has diffused through the walls into the interior of the hermetically sealed bag, and some of the mixture of the gas from the inside has diffused through the walls to the exterior of the hermetically sealed bag.

Now in the event the charge confined in the bag consists substantially entirely of dichloro-difluoromethane, it will be found that substantially all of the diffusions noted are inwardly directed, so that there is a slight increase in pressure, above atmospheric pressure, within the hermetically sealed bag, since the walls thereof are considerably less impervious to air than to dichlorodifluoromethane. On the other hand, in the event the charge confined in the bag comprises the previously mentioned mixture of carbon dioxide and dichloro-difluoromethane (about 20% by weight CO_2 and about 80% by weight CCl_2F_2), it will be found that the inwardly directed diffusions and the outwardly directed diffusions are substantially balanced, so that there is little or substantially no change in the pressure within the hermetically sealed bag, since the walls thereof are about equally impervious to air and to carbon dioxide. Now these phenomena pertain to partial pressure considerations involved in the action of these permeable diaphragms, and it will be appreciated that when the desired diffusion balance is achieved, undesirable inflation of the hermetically sealed bag with air is avoided. In turn, this desired diffusion balance if substantially achieved when the permeability of the diaphragm to carbon dioxide approaches the permeability thereof to air, as the permeability thereof to CCl_2F_2 may be neglected, so that the outwardly directed permeation of the diaphragm by carbon dioxide compensates, at least in part, the inwardly directed permeation of the diaphragm by air. Now, of course, the rate of permeation of the carbon dioxide from the inside of the bag toward the outside thereof, or from the high partial pressure side of the diaphragm toward the low partial pressure side thereof, gradually declines as the quantity of carbon dioxide in the mixture contained in the bag is gradually reduced; however, an objectionable unbalance is not reached, employing the construction of the unit **20** described, in a time interval of at least 20 years, which time interval is substantially in excess of the expected useful life of the refrigerator cabinet **10**.

In the manufacture of the unit **20**, the two plastic sheets **21***a* and **21***b* are brought together and electronically sealed (or adhesively sealed) at three of the boundary edges thereof to produce a sack-like structure, open at one end thereof. The composite bat or mattress **22** is then placed into the interior of this sack-like structure, and the assembly is placed in a suitable processing chamber that is then closed and appropriately evacuated in order to subject the interior of the bag and the composite mattress to a sub-atmospheric pressure, so as to eliminate therefrom substantially all of the air and the moisture. The sub-atmospheric pressure condition in the processing chamber may be maintained for an appropriate short time interval in order to insure substantially complete removal of the air from the interior of the bag and the mattress. Thereafter gaseous carbon dioxide is introduced into the interior of the bag and flushed through the mattress so as to purge therefrom occluded air, particularly from the surfaces of the glass fibers of the mattress. This purging action is continued for a short time interval, and during the action the pressure in the processing chamber may be elevated somewhat above atmospheric pressure, and then later reduced back substantially to atmospheric pressure. At the conclusion of the purging action with carbon dioxide, the processing chamber is evacuated so as to remove therefrom a preponderance of the gaseous carbon dioxide, and so that a controlled amount or residuum of the carbon dioxide remains in the porous mattress **22**. This subatmospheric condition is maintained in the processing chamber for a short time interval; and of course, the amount of gaseous carbon dioxide remaining in the mattress **22** at the conclusion thereof is dependent both upon the sub-atmospheric pressure employed in this step and to the time duration thereof. At the conclusion of this step,

gaseous dichloro-difluoromethane is introduced into the processing chamber so as to complete the fill of the mattress 22 and the sack-like structure previously mentioned. When the pressure within the processing chamber is elevated to atmospheric pressure, there results a charge of gas therein essentially comprising a mixture of carbon dioxide and dichloro-difluoromethane. At this time, the remaining boundary edge of the sack-like structure is sealed electronically or adhesively, while the assembly is in the processing chamber, so as to produce the hermetically sealed bag of the unit 20. Then the process chamber is opened to accommodate the removal therefrom of the finished unit 20.

In the foregoing description of the method of manufacture of the unit 20, it was explained that the composite mattress 22 was first introduced into the sack-like strucutre and then subjected to the purging action of the gaseous carbon dioxide, and while this is considered to be the preferred and normal sequence of the steps, it is noted that it is entirely satisfactory to reverse the order of these steps in the method. Specifically, the composite mattress 22 may be subjected to the purging action of the gaseous carbon dioxide prior to the introduction thereof into the sack-like structure mentioned. More particularly, following purging of the mattress 22 with gaseous carbon dioxide, the same may be transferred to storage in an atmosphere of carbon dioxide, and then subsequently removed from storage and placed in the sack-like structure in the previously described processing chamber. At this time, further purging of the assembly with gaseous carbon dioxide in the processing chamber may be effected, if desired.

In view of the foregoing description of the method of manufacture of the unit 20, it will be understood that the charge confined in the hermetically sealed bag inherently comprises a mixture of CO_2 and CCl_2F_2, and that the ratio therebetween may be readily controlled and preset by preselection of the subatmospheric pressure to which the processing chamber is subjected, following the purging step with CO_2 and preceding the introduction thereinto of CCl_2F_2. Specifically, the lower this subatmospheric pressure is selected, the smaller will be the amount of CO_2 in the ultimate charge of gas confined in the hermetically sealed bag of the unit 20.

Of course, in the assembly of the refrigerator cabinet 10, the required heat-insulating units 20 are placed between the cabinet walls 11 and 12 for the insulating purpose.

In the present construction of the improved heat-insulating unit 20, a thermal conductivity (k) is obtained that has a value of about 0.12 B.t.u. per hour per square foot per inch of thickness per °F.; whereas corkboard has a corresponding value of k of 0.33 and expanded vermiculite has a corresponding value of k of 0.48. Thus the thermal conductivity of the improved heat-insulating unit 20 is only about ⅓ of that of these good heat-insulating materials named that are frequently used in refrigerator cabinets; whereby the substitution of the heat-insulating units 20 of the present invention renders it feasible to reduce by about ½ the normal spacing between the outer shell 11 and the inner liner 12 of the refrigerator cabinet 10 so as materially to increase the useful volume of the refrigerator space 13 within the inner liner 12, utilizing the outer shell 11 of given dimensions. Moreover, the weight of these heat-insulating units 20 is substantially less than that of conventional units thereby effecting a corresponding reduction in the overall weight of the composite household refrigerator.

Furthermore, the method of manufacture of the improved heat-insulating unit 20 involves a minimum number of simple and economical steps that may be readily carried out and that are inherently productive of the heat-insulating unit of the construction described.

In view of the foregoing, it is apparent that there has been provided a heat-insulating unit of improved construction and arrangement for ready incorporation into a refrigerator cabinet in the space between the metal outer shell and the metal inner liner thereof, thereby accommodating a substantial reduction in the wall thickness of the cabinet between the outer shell and the inner liner thereof and contributing materially to compactness and reduction in the weight of the cabinet.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A heat-insulating unit of deformable pillow-like construction and adapted to be conformed to the space disposed between the inner and outer walls of a refrigerator cabinet; said unit comprising an hermetically sealed bag having deformable sheet-like walls of low thermal conductivity that are highly impervious to gas, a deformable porous mass of solid heat-insulating material confined within said bag and generally filling out the volume thereof, and a charge of gas at substantially atmospheric pressure confined within said bag and completing the fill thereof and thoroughly permeating said porous mass of solid heat-insulating material; said charge of gas having a thermal conductivity lower than that of air and essentially comprising by weight about 15 to 25 parts carbon dioxide and about 75 to 85 parts dichloro-difluoromethane so that there is a substantial balance between the diffusions in opposite directions of carbon dioxide and of air through said walls at atmospheric pressure.

2. The heat-insulating unit set forth in claim 1, wherein each of said walls of said bag comprises a sheet of synthetic organic resin including polymers of vinylidene chloride, and said deformable porous mass of solid heat-insulating material essentially comprises a bat of glass fibers.

3. A heat-insulating unit of deformable pillow-like construction and adapted to be conformed to the space disposed between the inner and outer walls of a refrigerator cabinet; said unit comprising an hermetically sealed bag having deformable sheel-like walls of low thermal conductivity that are highly impervious to gas, each of said walls of said bag including a sheet of synthetic organic resin, a deformable porous bat of glass fibers confined within said bag and generally filling out the volume thereof, and a charge of gas at substantially atmospheric pressure confined within said bag and completing the fill thereof and thoroughly permeating said porous bat; said charge of gas having a thermal conductivity lower than that of air and essentially comprising by weight about 15 to 25 parts carbon dioxide and about 75 to 85 parts dichloro-difluoromethane so that there is a substantial balance between the diffusions in opposite directions of carbon dioxide and of air through said walls at atmospheric pressure.

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