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REFRIGERATOR CONSTRUCTION HAVING MEANS TO RESTRICT
MOISTURE IN THE WALLS OF THE CABINET
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Fig. 1

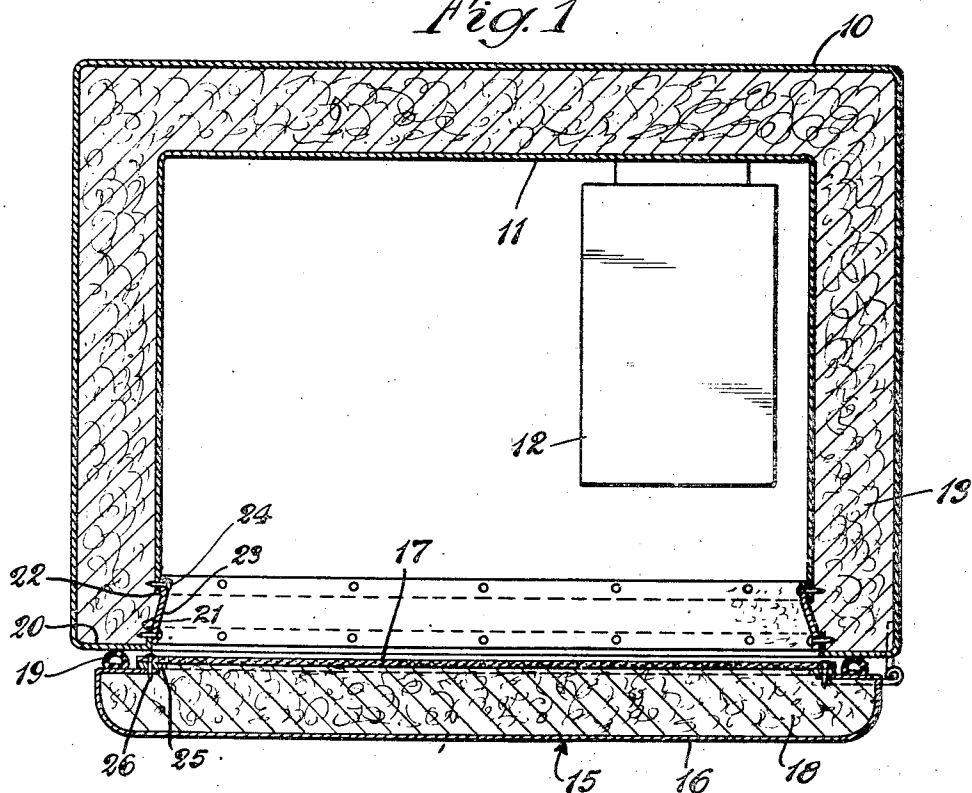


Fig. 2

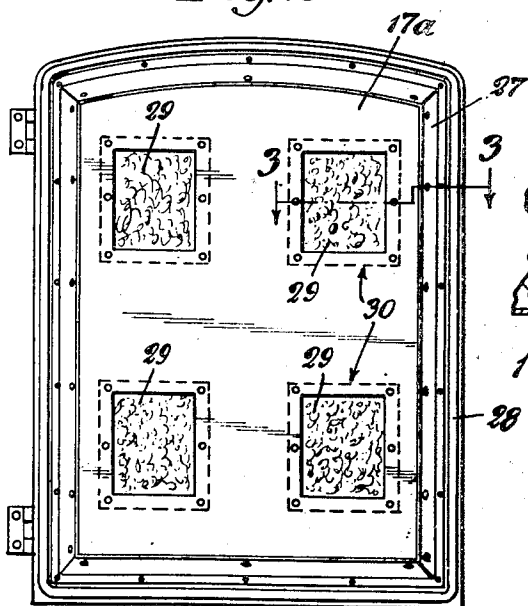
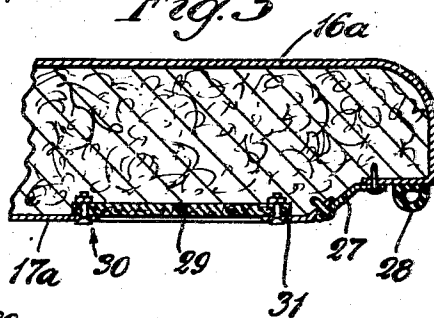


Fig. 3



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Fig. 4.

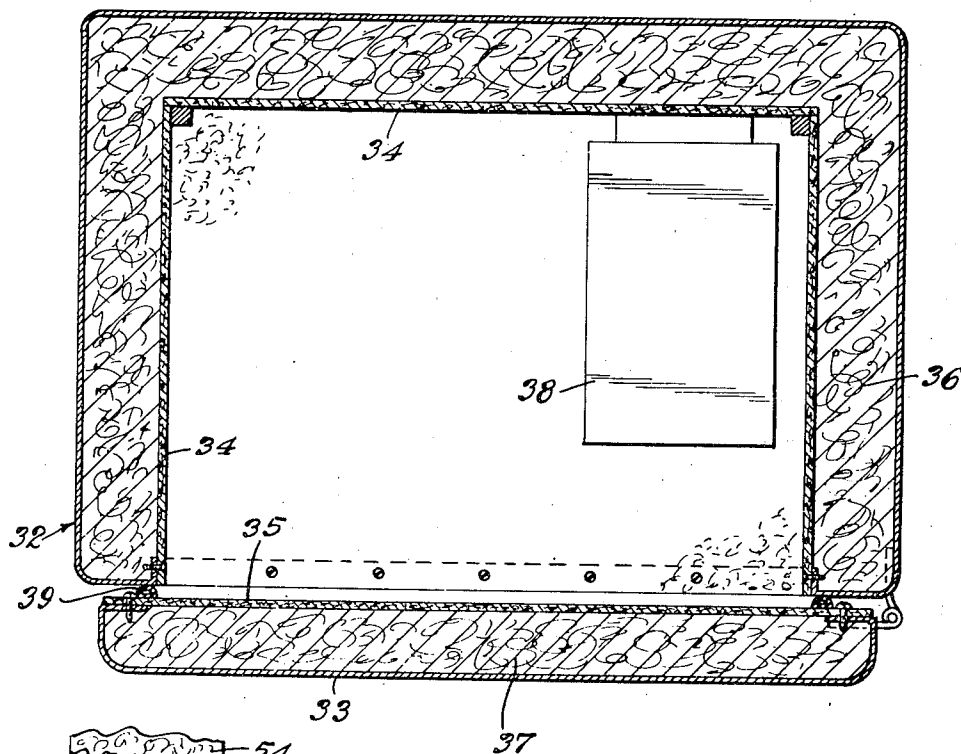
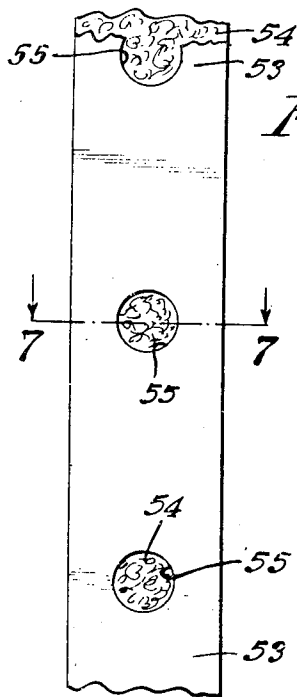


Fig. 6

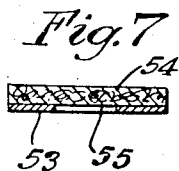
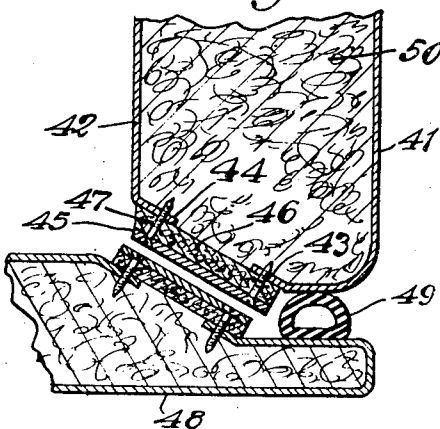


Fig. 7

Fig. 5



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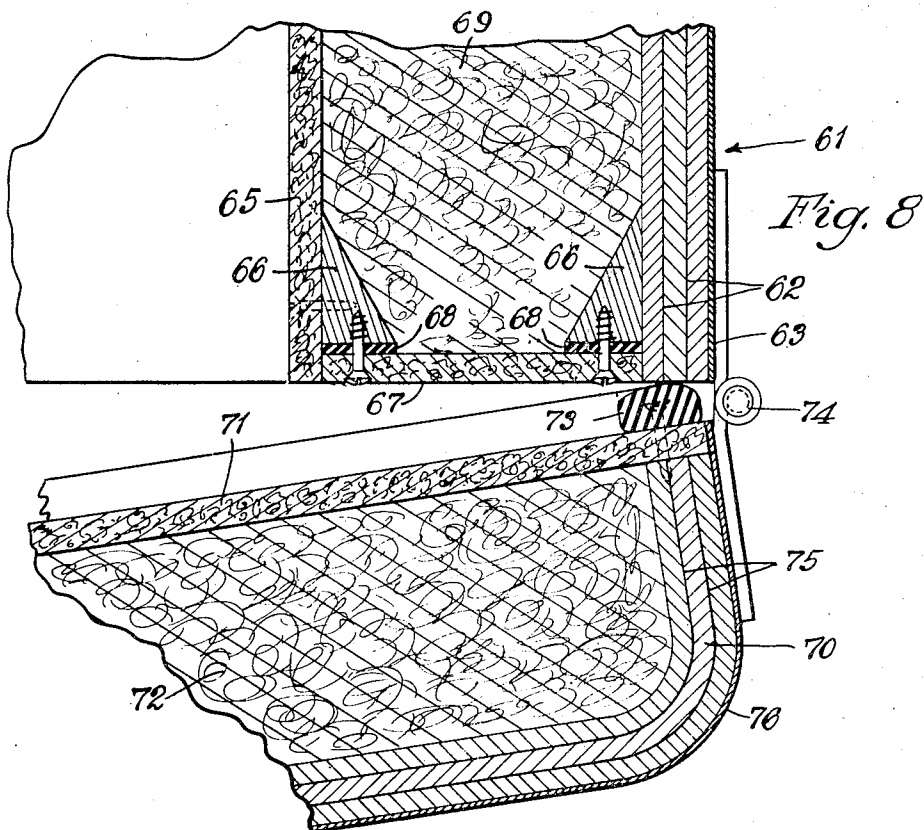
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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REFRIGERATOR CONSTRUCTION HAVING
MEANS TO RESTRICT MOISTURE IN THE
WALLS OF THE CABINETClark C. Heritage, Cloquet, Minn., assignor to
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Application August 11, 1944, Serial No. 548,946

10 Claims. (Cl. 62—89)

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The present invention relates to refrigerator constructions, and particularly to improvements for avoiding condensation in the insulation thereof.

The common refrigerator construction has a cabinet, a food compartment within the cabinet, insulation, such as fiber or other insulating material in the intervening space, artificial refrigerating means in the compartment, such as coils or units to cool the same, and a door on the cabinet for access to the food compartment. In detail, the cabinet and food compartment have registering openings, and a gap between the edges of the openings is closed by what is called breaker-strip. This is commonly made of material such as a plastic, impregnated fiber or equivalent durable material less heat-conductive than metal.

It is commonly secured by screws to flanges, or to the thin walls of sheet metal of which the cabinet and food compartment have long been made.

The door itself is usually a shell of metal forming the outer facing, with an inner facing opposed to the food compartment, and with insulation material between. The inner facing may be sheet metal, connected by material such as that of the breaker-strip to the outer shell, or it is entirely a panel of such plastic material secured by screws to a flange on the casing.

Pertinent to those constructions is the fact that the door usually seals the opening of the cabinet by pressure on a rubber or other cushioning strip, while the breaker strip is exposed to air in direct communication with the interior of the food compartment.

Construction like the above, and others having equivalent defects, have given considerable difficulty in use, especially in warm and humid climates or conditions. Doors in particular have dripped water. The insulation becomes wet in both door and cabinet, by reason of humid air entering the insulation, which latter has sufficiently cold parts to condense water vapor in the humid air.

One of the ways that air enters the insulation is by a pumping action resulting from opening and closing the door. While the door is being opened there is a suction. While the door is being closed, there is a pressure. When the door is open, cold air pours out the bottom of the door opening and warm humid air enters at the top. The pressure on closing the door forces some of this humid air into the insulation past the breaker strip. The common loose fit of the breaker-strip, and of the inner panel of the door, per-

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mit first removal of air from the insulation on opening the door. Then warm humid air replaces it. On shutting the door, more warm humid air is driven in. In the case of the door, the situation is more dangerous, because the opened door takes in atmospheric air almost entirely at the time that the cabinet takes in cooler drier air derived at least in part from the food compartment.

The refrigerating unit or coils commonly form frost on them, which is clear evidence of the fact that water to provide the frost is taken from the air. This is a dehydration procedure which both cools and dries the air in the food compartment to such an extent that there is between the interior and the exterior of the food compartment a high differential vapor pressure, tending to drive water vapor into the food compartment wherever transmission of vapor can occur. This pressure or force exists between any two regions of different temperature where the actual concentration of water vapor, as in the warmer region exceeds that in the other region. Thus, if there is water vapor, or condensate, in the insulation, it tends to dry out toward the food compartment when the door is closed through the same openings through which the described pumping action takes place. For this reason, many constructions of the kind above described have not evidenced the defective characteristics mentioned. They are designed, of course, not to exhibit them, but the design is with reference to normal usage. Where opening and closing is much more frequent than said norm, and especially in the more humid climates, the defects are evidenced by dripping water. Wetting of insulation also occurs without any visual evidence of it, but it is constantly being remedied, as during long periods of closure of the refrigerator. Nevertheless, wet insulation is undesired, because it leads to rusting, decay, settling of insulation, or other damage to the insulation and the metal parts of the structure, and also to greater heat loss and hence increased cost of operation.

The present invention aims to avoid the above-mentioned defects of refrigerator constructions.

It is an object of the invention to construct refrigerator cabinets and doors in such a way as to minimize or prevent the said pumping action, or breathing in and out of air.

Another object of the invention is to utilize the dehydrating action of the food compartment to impose drying conditions on the insulation by new and improved constructions.

Various other and ancillary objects and advan-

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tages of the invention will become apparent from the following description and explanation of the invention, as given with reference to the accompanying drawings in which:

Fig. 1 represents a horizontal cross-section of a domestic refrigerator showing inner wall, outer wall, insulation, and a door also having insulation.

Fig. 2 represents an alternative form of door suitable for the box shown in Fig. 1.

Fig. 3 is a fragmentary cross-sectional view on the line 3—3 of Fig. 2.

Fig. 4 is another form of refrigerator shown in horizontal cross-section in the manner of Fig. 1.

Fig. 5 is a fragmentary view of an inner and outer wall of a refrigerator showing a modified breaker strip in accordance with the invention.

Fig. 6 represents a modification of breaker strip for Fig. 5 having holes therein to expose the face of the gasket.

Fig. 7 is a cross-sectional view on the line 7—7.

Fig. 8 is a fragmentary view of a modified refrigerator construction made of fiber board and plywood.

The invention is not to be considered as limited to or by the embodiments thereof which are shown in the drawings and described herein-after.

The invention is applicable to the type of refrigerators first above described, and it is applicable to modifications of them, as now briefly referred to. The fact that steel has become a critical material in a national emergency has led to the design and construction of refrigerators of substitute material. For example, plywood and hardboard have been employed to form the cabinet and the food compartment in structures simulating the steel structures. These promise to offer trouble in that plywood is transmissive of water vapor, thus to foster the entry through the cabinet walls of moisture from the atmosphere. The presence of insulating fiber in the cabinet, for example, against a plywood exterior wall will make the said wall transmit more vapor from the atmosphere into the cabinet than if air were adjacent the cold side of such cabinet wall. This is a fact believed to be known by few. It is known by many that water-vapor will pass through such walls as plywood, and to limit this, a coat of paint or other finish is supplied on the outside, and is of suitable material selected to limit the vapor transmission characteristics of the coated wall. These will not function in full measure when insulation is placed against the cold side of such wall.

As to the interior of the plywood, or hardboard, or like structure, the food compartment will favorably transmit water vapor, even with insulation on the warm side of its walls. A delicate problem of design arises to balance the entry and exit of vapor into the insulation by wall transmission. Add to this the pumping action, and serious difficulties are more likely to be encountered.

Without regard to the details of construction of a refrigerator having insulation therein, in cabinet or door or both, which insulation is capable of receipt of and damage by condensation of water vapor in the space containing the insulation, the invention has several broad objectives in function:

- (1) To keep the insulation dry by minimizing forces to introduce water vapor to it, and
- (2) To keep the insulation dry by increasing

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forces which tend to move water vapor from the space containing the insulation.

The first objective is accomplished by providing cabinet walls or outside door wall, which is of material or construction which is substantially non-transmissive of water-vapor; and by enclosing the insulation in means substantially impervious to the convective flow of air induced by the pumping action of the door.

The second objective is accomplished by providing in the area of the walls, which area confines the insulation and separates it from the relatively dry cold atmosphere of the food compartment (assuming the cooling units to be in operation), at least a portion of the area which is suitably transmissive of water vapor.

The extent to which absolute perfection is approached in one case determines how close absolute perfection must be approached in the other case. Thus, where only a relatively smaller transmissive area is provided for dehydrating the insulation, the walls exposed to the atmosphere must be relatively more sealed against transmission of vapor and flow of air. And, where a relatively large area is provided for dehydration of the insulation, the more perceptible relatively may be the transmission of vapor into the insulation, and the more perceptible relatively may be the flow of air into the insulation.

It must be appreciated that in practice and in commerce perfection is only a goal, and that design with factors of safety is often as good as the attained goal, and less expensive. Therefore, where the term "substantial" is used, it includes not only an absolute condition but also a low degree of departure from perfection.

Fig. 1 represents a conventional type of domestic refrigerator having a steel cabinet 10, a steel food compartment 11, and a freezing unit 12 shown in diagram only. Suitable insulation, such as packed vegetable fiber, rock wool, corrugated paper, or the like, is indicated at 13 between the cabinet and food compartment walls. A door 15 has a steel shell 16, a back plate 17 of poorly conductive material such as resin-impregnated fiber, and insulation 18, like insulation 13. A hollow rubber cushion strip 19 carried by the door seals the space between the door 15 and flange 20 of the cabinet 10. Flange 20 has a lip 21 directed toward a lip-like edge 22 of the food compartment 11 with an intervening space closed by breaker-strip 23.

Breaker-strip 23 is tightly secured to the lips 21 and 22 by means such as screws 24 and for the present invention this is effected to make an air-tight joint, with or without interfacial adhesive for aiding in that function. Breaker strip 23 is of necessity impervious to convective flow of air or water vapor, and in accordance with the present invention must permit the conductance by transmission of water vapor. Hard-pressed fiber board, suitably laminated paper, suitably impregnated fabrics, wood veneer, certain protein or other plastics, and many other sheet-like materials are available for selection to provide such a breaker strip 23.

Thus, the breaker-strip 23 is exposed at the door opening to the drying atmosphere inside compartment 11, when the freezing unit 12 is in operation. Any vapor leaking into the insulation 13 by any means of entry, to the extent that it provides vapor pressure exceeding that in the compartment 11, tends to move through the breaker-strip and thus to dry the insulation.

The door 15 has its back plate 17 likewise sealed

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by an air-tight joint by a construction including gasket 25, and screws 26. The gasket has the same characteristics in function as to its services and its material, as the breaker-strip 23, namely to prevent air movements into and out of the insulation 18, while offering a vapor transmission channel for drying out undesired acquired moisture inside the door. Adhesive between the gasket and adjacent surface may be used to perfect the joint. It is noted that the gasket 25 is exposed to the atmosphere which is constantly dehydrated by the freezing unit 12.

Figs. 2 and 3 show an alternative form of door for the box of Fig. 1. The door body 16a is of steel and the back panel 17a is of steel mounted on the door body by breaker strip 27 to prevent heat transfer. The strip 27 is of plastic composition and for the purpose of the present invention it is cemented by plastic or other material to plates 16a and 17a to give an air tight joint at the interface, especially between any bolts or screws which may also be used in securing the strip 27. Plate 16a has cushion 28. Plate 17a carries "vapor windows" 29 exposed to the drying interior of a refrigerator. These windows are of air-tight material, like the breaker-strip material 23 of Fig. 1, and are sealed air-tight to the steel plate 27, by stove-bolts or the like 30 using additional sealing cement 31 of suitable nature, if the material is so rigid, such as the illustrated fiber hardboard 29 might be, and if the bolts 30 are so spaced, as to require additional sealing.

Fig. 4 represents a modification of Fig. 1, in which the shells 32 and 33 of the body and the door, respectively, are of steel, as in Fig. 1, and in which the food compartment 34 and the inside door panel 35 are of material such as a fiber hardboard. Any mechanical construction is suitable which provides against air convection into the cabinet insulation 36 and the door insulation 37. The freezing unit 38 dries the air as the rubber seal 39 on the closed door excludes the outside atmosphere. The dry cold air thus establishes a favorable vapor-pressure differential through the hardboard material when there is undesirable moisture content in the insulation from any cause.

Fig. 5 is a modified breaker-strip construction for another conventional style of domestic refrigerator, of which a steel cabinet wall is represented at 41, an interior steel food-compartment wall at 42, each providing respectively opposing lips 43 and 44 with a gap to be spanned by breaker-strip. A conventional plastic-type of breaker-strip 45 is employed which is per se too impervious to the transmission of water vapor, and too rigid for an air-tight joint when mounted directly across the gap.

To provide for sealing against air-movement, a sealing gasket 46 is interposed between the lips 43-44 and the strip 45, when the screws 47 are inserted. The gasket is of material which readily transmits water vapor, for edgewise exit, while being impervious to the free flow of air. Any material of the kinds already named and others may be employed as the gasket material. In this construction the accompanying style of door closure must be such that the gasket is exposed to the dry interior of the refrigerator. There is also shown a conventional and suitable door 48 and its rubber seal 49. Insulation as of fiber 50 fills the space between walls 41 and 42. Door 48 has parts like 45-46.

Figs. 6 and 7 show a modified breaker strip 53

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for use in a construction like that of Fig. 5. It has rear gasket 54 like that in Fig. 5, and holes 55 in the breaker strip to expose more area of the gasket 54.

Fig. 8 represents modifications of refrigerator constructions which may, for convenience here, be referred to as a "war time model" dispensing with steel or metal. The cabinet is constructed of wood or fiber board. Wood and fiber materials are highly transmissive of water vapor. To minimize this, the cabinet 61 is of plywood with resin glue lines 62 and a surface coat of vapor-resistant enamel 63, these tending to minimize the transmission capacity of the cabinet wall 61 to water vapor.

The food compartment 64 is of hardboard made of pressed fiber, as in Fig. 4, chosen for its ready transmission of water vapor and for its imperviousness. The type of hardboard known as lignin-bonded is suitable.

Any construction may be employed, but one is shown merely for example. There are ledge-strips 66 secured to the cabinet 61 and food-compartment 64, against which a like hardboard breaker-strip 67 is secured with packing gaskets 68 as of rubber, for air-tightness, to protect insulation 69.

A door of similar construction is shown. This has an enameled molded plywood shell 70, hardboard inner-plate 71, insulation 72, and door seal 73. A hinge 74 is indicated. Shell 70 has resin-glue lines 75 and exterior vapor-resistant enamel 76.

It is of course to be understood that many other constructions, not shown may be used, such as "vapor windows" in the walls of the food compartment, without departing from the spirit and scope of the invention as set forth in the appended claims.

I claim:

1. A refrigerator comprising a cabinet of material and construction which provides wall area substantially impervious to the transmission of water vapor, a food compartment located within said cabinet and spaced from the interior walls of the cabinet by a space for insulation, thermal insulation in said space of material capable of receiving condensation of water vapor which may be present in said space, said cabinet and said compartment having registering openings for access to said compartment from outside said cabinet, a door mounted on the assembly of said cabinet and compartment to swing for closing said opening in the cabinet, space-confining strip material serving as part of the confining wall area for said space and insulation therein and connecting the walls of said cabinet and said compartment at their openings, said material being in communication with the region within said compartment when said door is in closed position, and artificial refrigeration means within said compartment for cooling the interior thereof, the wall area confining said insulation and separating the same from communication with the food compartment being substantially impervious to the flow of air out of and into said insulation by the suction and pressure of respectively opening and closing said door, and at least a portion of said wall area being transmissive of water vapor for the flow of water vapor from said insulation to the interior of the compartment for effecting the dehydration of said insulation as to any water vapor leaking in said space, the cooling action of said refrigerating means effecting such dehydration when said door is closed.

2. A refrigerator according to claim 1 in which the door has inner and outer facings with space between them for insulation, thermal insulation in said space in the door of material capable of receiving condensation of water vapor which may be present in said space, said space being substantially sealed against flow of air out of and into said space by the suction and pressure of respectively opening and closing said door, said outer facing being substantially impervious to the transmission of water vapor, and at least a portion of said inner facing which portion is in communication with the interior of said compartment being transmissive of water vapor for the flow of water vapor from the space within said door to the interior of said compartment for effecting like dehydration of the insulation in said door as to any water vapor in said space.

3. A refrigerator comprising a cabinet of material and construction which provides wall area substantially impervious to the transmission of water vapor, a food compartment located within said cabinet and spaced from the interior walls of the cabinet by a space for insulation, said food compartment having walls of material which is substantially impervious to the flow of air and to the transmission of water vapor, thermal insulation in said space of material capable of receiving condensation of water vapor which may be present in said space, said cabinet and said compartment having registering openings for access to said compartment from outside said cabinet, a door mounted on the assembly of said cabinet and compartment to swing for closing said opening in the cabinet, space-confining strip material serving as part of the confining wall area for said space and insulation therein and connecting the walls of said cabinet and said compartment at their openings, said material being in communication with the space within said compartment when said door is in closed position, and artificial refrigeration means within said compartment for cooling the interior thereof, said strip material being substantially impervious to the flow of air out of and into said insulation by the suction and pressure of respectively opening and closing said door, at least a portion of the space-confining area of said strip material being transmissive of water vapor for the flow of water vapor from said insulation to the interior of the compartment for effecting the dehydration of said insulation as to any water vapor in said space, the cooling action of said refrigerating means effecting such dehydration when said door is closed.

4. A refrigerator comprising a cabinet of material and construction which provides wall area substantially impervious to the transmission of water vapor, a food compartment located within said cabinet and spaced from the interior walls of the cabinet by a space for insulation, artificial refrigeration means within said food compartment for cooling the interior thereof, said food compartment having walls of material which is substantially impervious to the flow of air and to the transmission of water vapor, thermal insulation in said space of material capable of receiving condensation of water vapor which may be present in said space, said cabinet and said compartment having registering openings for access to said compartment from outside the cabinet, a door mounted on the assembly of said cabinet and compartment to swing for closing said opening in the cabinet, space-confining strip material serving as part of the confining wall area for said space and insulation therein and connected to the

walls of said cabinet and said compartment at their openings, said material being substantially impervious to the flow of air and to the transmission of water vapor and being in communication with the interior of the compartment when said door is closed, and gasket means sealing the space between said strip material and said walls to which the strip material is connected, said gasket means substantially sealing the connection against flow of air, said gasket means being of material which is transmissive of water vapor and being exposed at least edgewise for communication with the interior of said compartment when said door is closed, whereby to permit transmission of water vapor through said gasket means from said insulation to the interior of the compartment for dehydration of the insulation as to any vapor in said space, the cooling action of said refrigerating means effecting such dehydration when said door is closed.

5. A refrigerator having a cabinet, a food compartment inside said cabinet, an artificial refrigerating means in said compartment, and a door for the cabinet for access to said food compartment, said door having an outer facing which is substantially impervious to the transmission of water vapor and an inner facing providing a space between it and the outer facing for insulation, thermal insulation in said space of material which is capable of receiving condensation of water vapor which may be present in said space, said space being substantially sealed against the flow of air out of and into said space by reason of the suction and pressure of respectively opening and closing said door, at least a portion of the wall area confining said space and separating the insulation in said door from the interior of said compartment being pervious to the transmission of water vapor for the flow of water vapor from said insulation to the interior of the compartment for effecting the dehydration of said insulation as to any water vapor in said space, the cooling action of said refrigerating means effecting such dehydration when said door is closed.

6. A refrigerator comprising a freezing unit, inner and outer walls and thermal insulating material in the space between the walls, the said space being substantially sealed to air-tightness whereby to minimize pumping action of air into and out of the space, total area of the wall exposed to the atmosphere being relatively poorly pervious to the transmission of water vapor from the atmosphere to the insulation, the area of the wall exposed to the interior of the refrigerator and to the atmosphere therein subjected to cooling by said unit, having at least a portion of its area readily transmissive of water vapor.

7. A refrigerator having in combination a cabinet providing a chamber with an opening in the cabinet to said chamber, a door closure for said opening, means to seal said door in closed position against the convective passage of air into and out of the chamber at the junction of the closed door and the cabinet, and refrigerating means in said chamber; said cabinet and door on their outside area exposed to the atmosphere being relatively impervious to the transmission through said area of water vapor from the atmosphere, said door and cabinet on all their areas both exposed to the atmosphere and to said chamber, being substantially impervious to the convective flow of air; at least said door or said cabinet being double-walled with a space between two walls, thermal insulation being pres-

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ent in said space; and some portion of a wall exposed to said insulation on one side and to the chamber on the other side being relatively highly transmissive of water vapor through said portion, whereby any form of water in said insulation has a channel for migration as vapor through said portion into the chamber as a result of the dehydrating action of said refrigerating unit on the confined atmosphere of said chamber.

8. In a refrigerator having double walls with intervening insulating space substantially tight against convective movement of air into and out of the space by reason of the pumping action of opening and closing a door of said refrigerator, thermal insulation in said space of a character to hold moisture condensed therein, wall-forming means in part defining said space with exposure thereof to the air in the food compartment, and a cooling unit for cooling said compartment, said means being readily transmissive of water vapor, whereby water vapor in air incidentally leaking from the air exterior to the refrigerator into said insulating space may be dissipated into the food compartment by transmission as vapor through said means by the differential pressure existing between said food compartment and the space, by operation of said cooling unit.

9. A refrigerator comprising inner and outer shells together providing an opening for closure by a refrigerator door, and together providing an insulating space between them and one or more spaces peripheral to the door opening for closure by application of closure means, thermal insulation in said space of a character to hold moisture condensed therein, closure means closing said peripheral space or spaces with a substantially air-tight seal whereby to prevent pumping air into and out of said space upon

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closing and opening the said door, said means being at least in portions thereof readily transmissive of water vapor and being exposed to the food compartment, and a cooling unit in said food compartment effective in operation to dehydrate the air therein to a low moisture content compared to air exterior to the refrigerator, whereby excess moisture leaking into said insulating space tends to dry out through said means into the food compartment.

10. In a refrigerator having a cooling unit in the food compartment thereof, and having a double walled insulating space in part confining said compartment, which space is substantially airtight, thermal insulation in said space of a character to hold moisture condensed therein, wall-forming means partitioning said space from the food compartment, said means being readily transmissive of water vapor, whereby the moisture incidentally present in said space tends to move through said means into the food compartment as a result of operating said unit to cool and dehumidify the air in the food compartment.

CLARK C. HERITAGE.

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