This invention relates to heat insulation and more particularly to a heat insulated window construction of a type for use in a flat-top, self-service refrigerator display cabinet.

An object of this invention is to provide an insulated window which will transmit light, but which will prevent the passage therethrough of any substantial amount of heat. A further object is to provide a window construction of the above character which is suitable for use in a refrigerator cabinet where products, such as packaged frozen food, are stored, displayed, and easily removed. A further object is to provide a refrigerator cabinet having doors incorporating therein a window construction of the above character.

A still further object is to provide a self-service cabinet which may be opened with one hand, and which may be easily closed after the product has been removed. Another object is to provide a heat-insulating, transparent structure. A still further object is to provide apparatus of the above character which is sturdy of construction, economical to build and operate, and which will give satisfactory results under varying conditions of use. Other objects will be in part obvious, and in part pointed out below.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts as will be exemplified in the structure to be hereinafter described and the scope of the application of which will be indicated in the following claims.

In the drawings:

Figure 1 is a perspective view of a refrigerator cabinet constituting one embodiment of the invention;

Figure 2 is a sectional view of another embodiment of the invention partially diagrammatic to show the distribution of the temperature drop in a window construction;

Figure 3 is an enlarged sectional view of the cabinet of Figure 1; and

Figure 4 is a sectional view on the line 4-4 of Figure 3.

In one illustrative embodiment of the invention, heat-insulating, transparent windows are incorporated in the lids or doors of a refrigerator cabinet. In distributing products such, for example, as quick-frozen packaged foods, difficulty has been encountered in providing proper refrigeration and at the same time displaying the products. In fact, even when frozen foods are attractively packaged, it is sometimes difficult to sell them because they cannot be properly displayed. In the past, when the available display cabinets have been used for frozen foods, the cost of operation has been excessive, with the result that the distribution costs have been high. In addition to this, the foods have been constantly subjected to the possibility of premature thawing and refreezing, which results in food spoilage and thus increases the cost and difficulties of distribution. It is an object of this invention to provide a display cabinet for frozen foods which will reliably maintain the foods at a safe temperature while, at the same time, the foods will be displayed and will be easily accessible. These and other highly desirable results are obtained without excessive cost.

In the illustrative embodiment of this invention, the foods are stored in a flat-top display cabinet having horizontally sliding doors or lids. Packaged frozen foods are carried within the cabinet upon vertically movable trays or elevators, and these trays are properly positioned at all times so that the top packages upon each tray are held adjacent the lids. The cabinet is of the self-service type, and the customer may open the cabinet by pulling the lid outwardly, and may then remove one or more packages of the food and reclose the lid by merely pushing it inwardly. By providing a horizontal opening in the top of the cabinet, the heavy cold air tends to remain in the cabinet even though the lid is open, and as a result, a very small amount of warm air enters the cabinet. Furthermore, when the cabinet is partially filled, most of the air space below the packages, and the packages themselves form a cover or lid for this air space when the sliding lid is open. In this manner, the cold air within the cabinet is protected and is not replaced by warm air. This materially reduces the possibility of the temperature within the cabinet rising to a point where the food will be partially thawed.

Furthermore, when warm air enters the cabinet, it carries with it a large amount of moisture, and when this air is cooled, this moisture condenses and forms frost upon the refrigerating surfaces. The forming of frost in cabinets of this character is a very serious problem, as the frost insulates the refrigerating surface, and in maintaining the proper cabinet temperature, an extra load is placed upon the refrigerating equipment. Such a coating of frost may even cause the temperature within the cabinet to rise to a point where the food will be damaged. It is thus seen that by preventing the entry of warm air into the cabinet, many of the difficulties normally encountered during operation are materially re-
duced, and the products are maintained in proper condi-
tion.

In this embodiment, the top wall of the cabinet is provided with horizontal windows through which the contents of the cabinet may be readily seen. These windows are in the form of sliding lids, each having an opening through which access may be had to the cabinet. Each of these lids is in the form of a frame which holds a large number of closely spaced, parallel sheets of transparent material. These sheets divide the space within the frame into a number of horizontal sheet-like dead-air spaces, and due to the fact that the air spaces are thin and are positioned horizontally, they provide an excellent insulating medium.

In this connection, it should be noted that heat is transmitted by three different actions, that is, by conduction directly through a substance, by radiation directly through a transparent substance, and by convection through gas-filled spaces in which the gas, such as air, is heated and rises from or along a warm surface to replace cooler and heavier air. With the present type of window, conduction is very small as heat is not readily transferred in this manner through either the transparent insulating material or the air. Likewise, radiation is small as the normal light radiates very little heat.

Furthermore, convection is largely eliminated as the basic conditions necessary for convection are not present. That is, with the horizontal top window, the heat must move downwardly from the warm outside wall to the cold inside wall, and the temperature drop through the window results in each air space having a bottom wall which is colder than its top wall. Thus, the air in the bottom of each air space is colder than the air in the top of this space, and due to the cooler air being heavier, there is no tendency for vertical circulation of the air. It had been found that convection is largely eliminated by making these air spaces of a thickness of three-eighths of an inch or less. With an air space of this thickness, the air throughout the space is effectively stratified, so that the warm film of air covers the top wall and the cooler film of air covers the bottom wall. In this manner, a transparent insulating medium is provided which maintains heat transfer at a minimum and also avoids the difficulties encountered in providing a vacuum chamber.

The present invention relates to transparent thermal insulation of the character which can be applied in a variety of different structures. Certain of the advantages of the invention are associated with a horizontally extending window structure, although many of the advantages are of a general nature and can be obtained when the invention is applied to a vertically extending window or door. Thus, for example, the window structure is admirably suited for use in vehicles such as trains and aeroplanes where light-weight, heat-insulating panels are desirable.

Passing now to a more detailed discussion of the present embodiment and the specific details thereof, the entire unit is shown in Figure 1 of the drawings with the cabinet indicated at 2, and a refrigerating unit indicated at 4. This refrigerating unit includes a motor-driven compressor, a condenser and a receiver, and control means which are arranged for operating the compressor in accordance with the temperature within cabinet 2. The evaporator of the refrigerating unit is in the form of a coiled pipe unit which extends around the inner side walls of the cabinet (see Figures 3 and 4), indicated at 6, and will be discussed more in detail below.

Referring particularly to Figure 3, cabinet 2 is formed by an outer metallic shell 8 and an inner metallic shell 10, and these two shells are spaced apart with the space therebetween filled by a rigid insulating material 12, illustratively compressed cork-board. The top edges of the shells are joined by a top of a strip 13 of heat-insulating composition board so that the space occupied by the insulating material is hermetically sealed and the inner shell is insulated from the outer shell. The cabinet is supported at each corner (Figure 1) by four legs 14, there being one leg at each corner.

The top wall of the cabinet is in the form of a frame which carries eight sliding lids 16, with four lids upon each side of the cabinet, and in this embodiment, each lid is provided with a handle 18 by which it may be pulled outwardly in drawer fashion to permit access to that particular portion of the cabinet. Referring again to Figure 3, extending along and in contact with the inner side walls of inner shell 10 is a corrugated liner 20 having horizontal corrugations. This corrugated liner forms a plurality of elongated recesses between itself and the inner side walls of the inner shell, and the coiled pipe unit extends through these recesses. The coiled pipe unit and the liner form a heat-transfer unit whereby the heat is effectively withdrawn from the cabinet, and by providing this construction, the unit is sturdy and cooperates with the shell structure to form a sturdy cabinet. At each end, this heat-exchange unit is provided with two vertically extending strap members 22, and spaced along each side of the cabinet to permit access to that particular portion of the cabinet 20. Each strap member 22 is fastened to the top by a metallic block 24 and is held thereto by a screw 26, shown best in Figure 4. Block 24 fills the space between the top of the strap member and the wall of the inner shell and extends along the adjacent top portion of the liner 20. Each strap 22 is attached to a similar block 27 by a screw 29.

The interior of cabinet 2 is divided into four compartments by means of four glass shelves, the baskets 28 which are removable positioned transversely within the cabinet. The construction of baskets 28 is best shown in Figures 3 and 4, there being at the bottom a rectangular frame 28 and at the top a similar rectangular frame 30, and extending between these frames are vertical bars 32. The bottom of the basket is formed by three cross straps 34 which are equally spaced and extend transversely of frame 28. Extending across the top of each basket at the center is a brace strap 36. At the center of each end of the basket are two vertical straps 38 (Figure 4) which are spaced apart to provide a vertical slot 36 to be referred to below.

Positioned within each of baskets 28 is a tray 46 having a flat bottom and upturned side and end walls, which is supported at its ends by a pair of angle brackets 42. Each of angle brackets 42 has one side welded to the central lower portion of the end wall of the tray, and the other portion of the angle brackets extends through the adjacent slot 38 between straps 36. Bracket 42 is removably attached to a supporting cord 44 which is held by a clamp 46 and which extends upwardly with its upper end coiled about and attached to a large sheave 45 of a pulley generally referred to at 48.
Pulley 48 is supported on block 24 by a stud bolt 50 which has a bearing portion 52 which fits against strap member 23 and assists in holding the strap member in place. Pulley 48 is provided with a small sheave 54 about which is coiled a cord 56 with the end of the cord attached to the sheave.

The other end of cord 56 extends downward and is adjustable by means of a buckle 58 and a coil spring 60. Coil spring 60 is hooked at its lower end to a pin 62 (see also Figure 3) which is riveted to the lower end of strap member 23. Thus, the two springs 60, acting through cords 56, pulleys 48 and cords 44, resiliently support the tray, and the tray moves up and down depending upon how much load it is carrying. That is, when the tray is empty, it is at the top of the cabinet, and as packages are piled onto the tray, the tension on the springs 60 is gradually increased so that the springs are stretched out and the tray moves downward.

The tension of springs 60 and the ratio between the sizes of the two sheaves of the pulleys 48 are so adjusted that the weight of one layer of packages moves the tray downwardly the thickness of the layer of packages. Thus, the top layer of packages is always at the top of the cabinet. The initial adjustment of the tension of each of springs 60 is obtained by adjusting the lengths of cords 44 and 56. Each of cords 56 is adjusted at its buckle 58, and each of cords 44 is adjusted by pulling the end of the cord downwardly through its bracket 42 and putting clamp 43 in place. Such an adjustment is normally sufficient even under varying conditions, but when conditions change sufficiently, readjustment is not difficult.

As indicated above, the top of the cabinet is formed mainly by eight windows in the form of lids 16, and these lids are carried by a frame structure which is removably attached to the top of the side walls. This frame structure comprises a longitudinal frame member 64, a transverse end frame member 66 at each end, and three intermediate transverse frame members 68. As shown best in Figure 4, transverse frame members 68 extend over the side edges of the baskets 28, and each of the lids on each side of the cabinet is over each of the baskets. Thus, the products within each compartment may be viewed through a window and removed through an opening on either side of the cabinet.

Each of lids 16 is formed by a frame of moulded material which rigidly holds a number of sheets of transparent insulating material. Each of the side walls 88 of the frame is provided with an angular side face 90, and as shown in Figure 3, the end of the frame which is at the center of the cabinet is similarly shaped. Walls surrounding the opening which is covered by the lid are shaped to snugly receive the lid, and these walls securely support the lid as it is slid outwardly away from the center of the cabinet. Accordingly, each of frame members 64 is provided with a top board 70 and a brace 72 which is narrow at the top and which flares outwardly toward the bottom with two angular side faces 74, and each of end frames 68 is provided with a similar top board 76 and a brace member 78 which has an angular side face 80. Longitudinal frame 64 is similarly constructed with a top board 82 and a brace member 84 having angular side faces 86. Thus, each lid is mainly supported on the angular faces so that the weight of the lid aids in maintaining a heat-tight seal around the lid. As shown best in Figure 1, extending along the edge of the cabinet and over the top of each lid is a top board 92 which braces the lid-supporting structure. In use, a lid may be pulled out with one hand, and after a package has been removed the lid may be pushed shut by either the hand or the body. Thus, the act of removing a package may be a one-hand operation.

In this embodiment, the transparent insulating material carried by the lids is in the form of a thick pane of glass 96. The top, a thin pane 98 at the bottom and a number of sheets of cellophane 100 equally spaced between the two panes. The panes and the cellophane are rigidly held at their edges and are positioned so that the air space between the two panes is divided into seven thin layers of equal thickness, each air space being approximately three-eighths of an inch thick. As has been pointed out above, it has been found that by providing horizontal air spaces of substantially the thickness disclosed, the entire body of air in each space becomes stratified, thereby forming an excellent heat-insulating medium.

The lower pane 98 is of Lucite which is a synthetic composition which is transparent and rigid, and which has low heat absorbing ability. Thus, pane 98 provides excellent heat insulation, and when the lid is pulled out and the pane is exposed to the warm air, it will not become fogged. The upper pane 98 is of glass and thus will not be scratched or damaged during normal use.

Referring to Figure 3, at the upper left-hand edge of the cabinet, a vertically sliding stop 94 is provided (see also Figure 4) which normally extends upwardly beyond the lower edge of the lid frame to a point adjacent the pane 88. Thus, as the lid slides outwardly, the stop prevents movement of the lid beyond the edge of the opening. Stop 94 may be slid downwardly away from the lid when the lid is to be removed.

In this embodiment, provision is made to light the interior of the cabinet without placing an undue load upon the refrigerating equipment. Accordingly, as shown in Figure 3, the bottom of longitudinal frame 64 is provided with an upwardly extending trough or channel 102, and positioned beneath this channel are suitable tubular fluorescent lights 104. The top frame 30 of each basket 28 is cut away on its two sides at 106 so that one light tube may extend over two baskets. The surfaces of channel 102 provide a reflector for the light and straps 108 protect the light from being hit by packages or otherwise injured. In addition to this, straps 108 act as stops to prevent the trays from moving a package against the light if the packages should become piled in the center of a tray. Furthermore, if for any reason the springs 60 holding a tray should be out of adjustment, the strap 35 extending over the particular basket would prevent the springs from lifting the packages against the lid.

Extending throughout the length of longitudinal frame 64 is an illuminated signboard indicated at 108. This signboard includes five triangular brackets 110 which carry at the top a reflector 112 into which are mounted suitable tubular lights 114. Mounted upon these brackets above each lid are four and a similar but larger strip 116. These strips bear notations listing the products which may be had by opening that particular lid, with strip 118 bearing the type of product such as "vegetables," "meat," "fish," etc., and each of the smaller
strips 176 bearing the name of a particular product with the price.

With the corrugated liner, a smooth inner surface is provided which is free from sharp corners and which may be injection molded. The structure is rigid, and at the same time, the evaporator pipes are sufficiently in contact with the liner to provide for satisfactory heat transfer between the pipes and the liner.

The pipe unit 6 is a continuous pipe so that the individual loops of the pipe are in the nature of a "square helix," and at each corner, the pipe unit is bulged outwardly and rounded to permit the pipe unit to expand and contract with changes in temperature.

In the embodiment of Figure 2, a transparent thermal insulation construction is provided wherein two spaced planes of glass 198 and 199 have therebetween seven sheets of Cellophane 200, which are the same as sheets 106 in the embodiment of Figures 1, 3, and 4. The frame in Figure 2 is shown with the background of the figure, and is the same structure as in the other illustrative embodiment of the invention. The seven sheets 200 divide the space between the planes into eight equal dead-air spaces of \( \frac{1}{2} \) inch thickness. Figure 2 has a diagrammatic representation of the actual insulation of this window structure mounted in a vertical wall with a temperature of 90°F, and a temperature at the right of 0°F. Under these illustrative conditions, there is a 9°F drop across each of the dead-air spaces, and the heat loss through the insulating window is 12.42 B. t. u. per square foot of area per hour.

With this construction, the temperature drop between the adjacent spaces is sufficiently small to prevent fogging or condensation of moisture within the spaces even under the most extreme conditions of use. Both of the planes are capable of withstanding wear without danger of scratching so that this window may be used in a door or in a vehicle where both sides of the window are constantly subjected to wear and abuse. The sheets of Cellophane are held fast, and the dead-air spaces are closed so that air does not circulate as when ventilation holes are provided. Even if there is leakage at the edges of the dead-air spaces, a good insulating effect is still obtained, and the water vapor does not materially interfere with the usefulness of the transparent thermal insulation as fogging and condensation are avoided.

It will thus be seen that I have provided a practical and efficient apparatus for accomplishing several objects heretofore mentioned as well as many others in a successful manner.

It has been found that this thermal insulation has insulating qualities which are equal or superior to those of an equal thickness of pure corkboard. This, a lightweight, transparent insulation is provided which approaches the optimum. In the illustrative embodiments referred to above, the spacing of the insulating members of such as to provide dead-air spaces of three-eighths inch and five-sixteenth inch, respectively. Under some circumstances, it is desirable to provide very thin dead-air spaces; thus, for example when an extremely thin window is desired, the spacing may be of the order of one-eighth inch or even one-sixteenth inch. This application is a continuation-in-part of my copending application, Serial No. 237,767, filed May 29, 1940, entitled "Refrigeration apparatus," issued on December 29, 1942, as Patent No. 2,306,585.

As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth, shown in the accompanying drawings, is to be interpreted as illustrative and not in a limiting sense. I claim:

1. In refrigeration apparatus of the character described, the combination of: a cabinet having a horizontal top opening; and a horizontally slidable door means providing a removable closure for said opening comprising, a frame of insulating material extending around the edge of said opening, and a plurality of sheets of transparent material within said frame including a pane of glass forming the surface which is the outer surface of the door means when the door means is in position to close said opening and a pane of synthetic resin having a lower thermal capacity than glass which is the inner surface of said door means when said door means is in position to close said opening.

2. In refrigeration apparatus of the character described, the combination of: a flat-topped cabinet having a top horizontal opening adjacent to one side of the cabinet and having the sides of the opening away from said side of the cabinet defined by wall portions which converge in a downward direction whereby the opening is provided with a rim with slanting upper surfaces which are adapted to slidably support a door means of a horizontally slidable door means providing a closure for said opening comprising, a rigid frame construction adapted to be positioned within and snugly fit said opening and presenting surfaces which converge in a downward direction corresponding to the similar surfaces about said opening, said frame having a central space, and a plurality of sheets of transparent material rigidly held by said frame in parallel relationship within said central space, said sheets including a top sheet of glass and a bottom sheet of plastic insulating material having a low mean thermal capacity.

3. In a refrigerator cabinet, a substantially horizontal top wall providing a heat insulating transparent closing comprising, a fixed frame having formed therein a rectangular opening with the frame extending along three sides of the opening and with the frame open along the other side, the side walls of said opening converging downwardly whereby the opening is bounded on three sides by a rim with slanting upper surfaces which are adapted to provide a support for a sliding closure, and a sliding closure positioned within said opening and supported by said rim and presenting surfaces mating with the slanting upper surfaces of said rim, whereby said closure rests upon said slanting upper surfaces with its own weight assisting in forming a wedge seal and whereby the closure may slide on two opposite slanting surfaces to permit access through the opening, said closure having a heat insulated transparent window therein which is provided with an upper surface of glass which is not easily damaged and is provided with a lower surface of transparent Lucite having a low mean thermal capacity.

4. In refrigeration apparatus of the character described, the combination of: a flat-topped cabinet having a top horizontal opening adjacent one of its vertical sides; and a horizontal slidable door means providing a removable closure for said opening comprising, a rigid frame construction adapted to be positioned within and snugly
fit said opening and to slide away from said opening beyond said vertical wall, and a plurality of sheets of transparent material rigidly mounted within said frame construction in parallel spaced relationship, said sheets including a top sheet of hard transparent material and a bottom sheet of a plastic insulating material having a low mean thermal capacity which is substantially less than the corresponding characteristic of glass.

CHARLES H. HERTER.

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