United States Patent

Falk

[15] **3,638,450**

[45] **Feb. 1, 1972**

[54] FLEXIBLE PARTITION FOR REFRIGERATED STORAGE CHAMBER

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[22] Filed: **Mar. 23, 1970**

[21] Appl. No.: **21,633**

[52] U.S. Cl. **62/329**, 62/447, 105/376, 160/23

[51] Int. Cl. **F25d 23/08**

[58] Field of Search 62/62, 64, 329, 447; 160/23, 160/25, 133; 105/376

[56] **References Cited**

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[57] **ABSTRACT**

A flexible convection partition for dividing a refrigerated storage chamber into multiple nongastight compartments, which partition is substantially vertically retractable and is storable near the ceiling of said refrigerated chamber.

8 Claims, 4 Drawing Figures

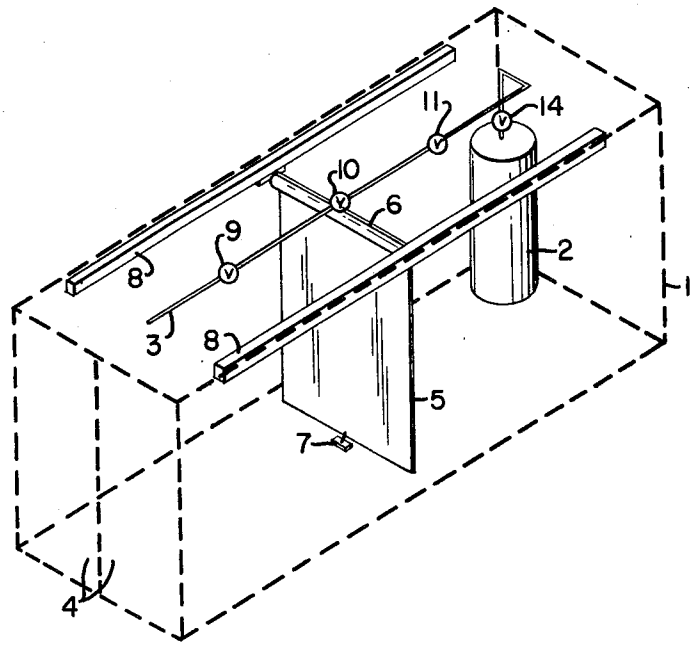


FIG. 1.

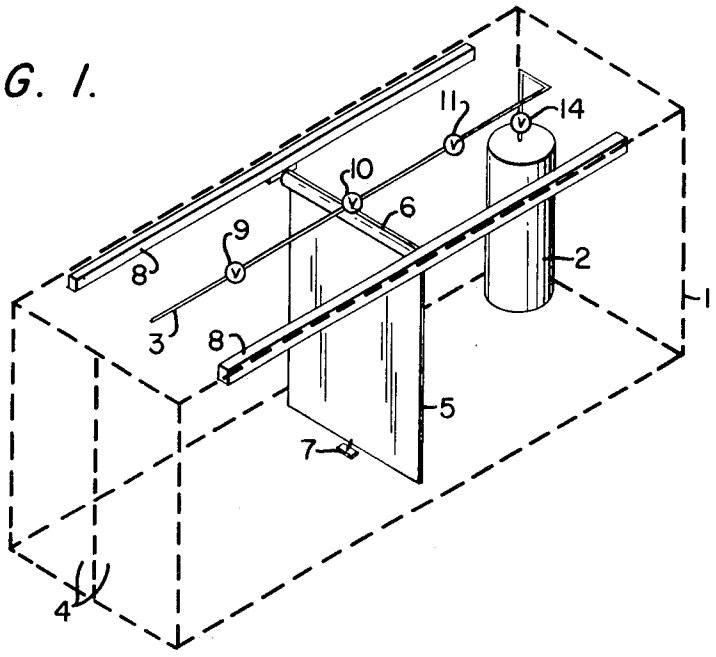
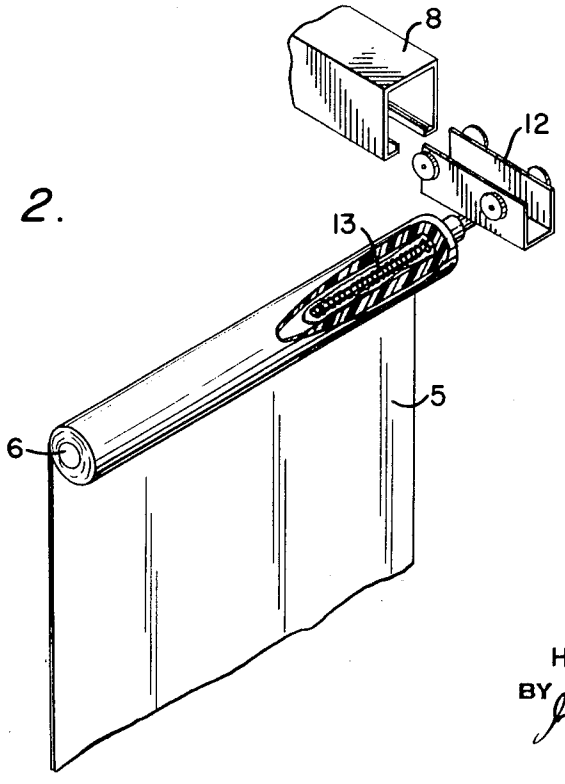


FIG. 2.



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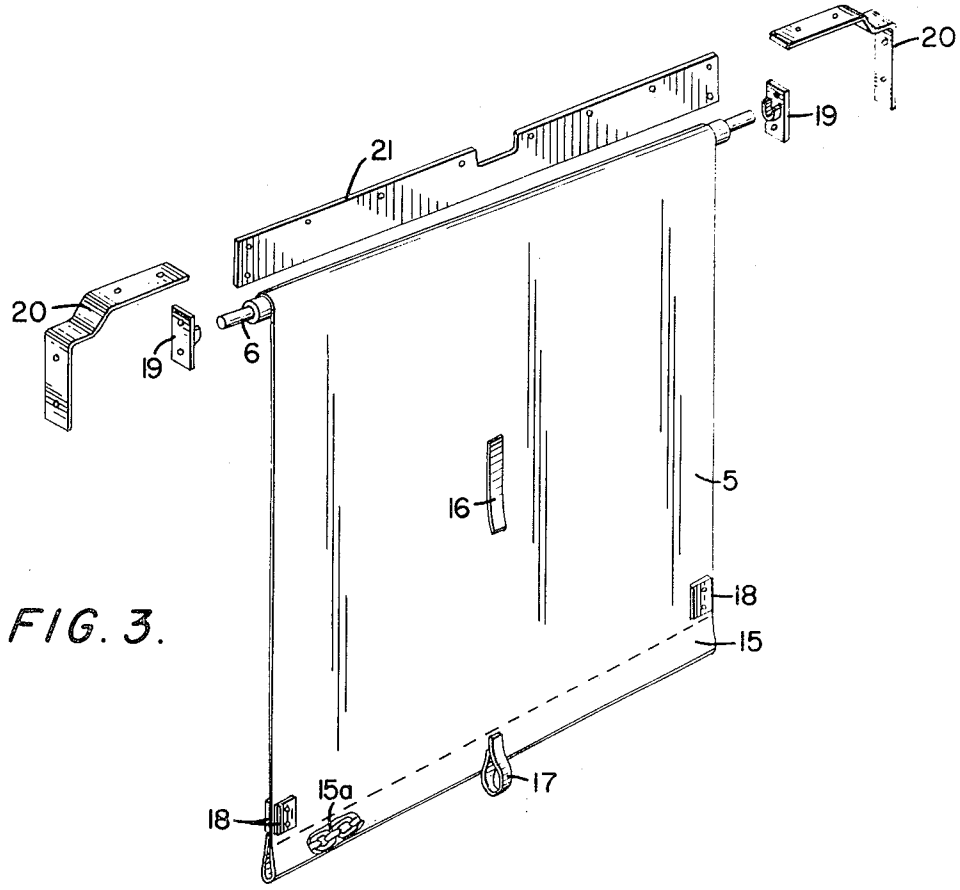

FIG. 3.

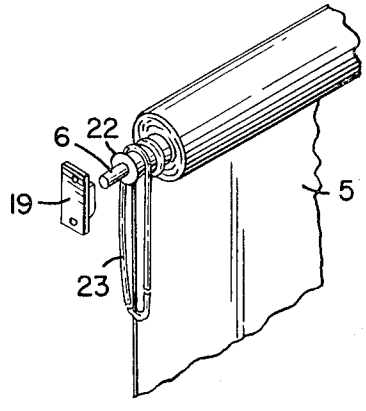

FIG. 4.

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FLEXIBLE PARTITION FOR REFRIGERATED STORAGE CHAMBER

BACKGROUND OF INVENTION

This invention relates to a method of and apparatus for low-boiling liquefied gas in transit refrigeration of perishable product wherein the refrigerant is sprayed into the product chamber.

Mobile product storage chambers, such as refrigerated trucks and trailers which are cooled by cryogenic fluid or mechanical refrigeration means, in general must maintain the product at a prescribed low temperature and in many cases under conditions of low humidity until such product is removed from said chamber. It is often difficult to maintain the product at an appropriate low temperature during the period when it is being loaded into and unloaded from a storage chamber. This is because the product introduced first into the storage chamber must remain exposed to the atmosphere until all the product is loaded and the chamber door can be closed. Similarly, when a refrigerated vehicle is being unloaded, the product which is last to be unloaded is exposed to the atmosphere for the full period between the opening of the refrigeration chamber door and removal of that product from the chamber. Loss of refrigeration and exposure of the product to conditions of high humidity become most significant in mobile refrigerated chambers used in multistop delivery operations.

In the past, rigid partitions of various types have been employed to compartmentize the storage chamber, thereby limiting the adverse effects of temperature and humidity experienced when storage chamber doors are open to the atmosphere. One prior art rigid partition is made from fiberglass reinforced plastic and is insulated with foamed-in-place polyurethane. It is held in position by an inflatable rubber tube attached to its perimeter. The tube is inflated with a hand pump which is built into the partition, and the partition can be positioned at any point along the length of the storage chamber or completely removed from the vehicle when it is not required. In another prior art rigid partition, a one piece ⅜ to 1 inch thick plywood "door" is provided which is hinged at the ceiling of the storage chamber, which may be swung up from the floor by means of a handle and hooked to the ceiling to maintain it in an open position for product loading and unloading. The partition is sized to provide a small clearance along its sides and bottom to prevent binding at the sides. Similar partitions made of thermal insulation material are used which are arranged to open as double doors or sliding partitions and which may be further arranged to traverse the length of the storage chamber by means of ceiling mounted tracks which engage partition mounted trolleys. Unfortunately, these prior art rigid partitions variously are cumbersome to handle, interfere with intercompartment access, require usable floor space as partition storage area when the partition is open, or require considerable floor space merely to gain access through the partition.

OBJECTS

It is an object of this invention to reduce the adverse effect or door openings on the refrigeration requirements and product quality in mobile refrigerated storage chambers by providing a storage chamber partition which requires no storage chamber floor space when in the open position, may be put into position quickly, requires no floor space to open or close, and which partition is flexible, light in weight and easy to operate.

Another object is to provide a method for loading and unloading refrigerated product using a flexible partition which improves refrigeration efficiency.

Other objects will be apparent from the disclosure and appended claims.

SUMMARY OF INVENTION

The objects of this invention are achieved in apparatus for refrigerating perishable products including a storage chamber, a container for storing liquefied refrigerant gas, overhead spray conduit means in said storage chamber, and conduit means for dispensing cold fluid from said container to said overhead spray conduit means by the improvements comprising a thin flexible partition made of gas-impermeable sheet material disposed transverse to the storage chamber, having a length at least equal to about the inside height of the storage chamber, and a width equal to the inside width of the storage chamber less a small amount sufficient to prevent binding between the partition and the storage chamber sidewalls; and flexible partition storage means disposed near the ceiling of and transverse to the storage chamber such that the full length of the flexible partition can be drawn to the ceiling for storage by said storage means and withdrawn from said storage means for partitioning said storage chamber.

Other objects are achieved by a method for refrigerating perishable products in a refrigerated chamber comprising:

a. providing a ceiling storable flexible partition transverse to the storage chamber at a predetermined location therein;
b. placing product within the chamber space between said partition and the chamber end opposite that end which is used for access, with the flexible partition in its stored position; thereafter
c. drawing the partition down from its stored position thereby partitioning said chamber;
d. placing product in said storage chamber between the drawn down partition and the chamber access end;
e. closing the chamber access door;
f. turning on the refrigeration; and turning off the refrigeration each time the access door is opened.
g. removing product from the chamber between the partition and the access end of said chamber;
h. terminating refrigerant flow to that portion of the storage chamber between the partition and the storage chamber access end;
i. raising the partition each time product is removed from the storage chamber portion between the flexible partition and that end of the storage chamber opposite the access end; and
j. drawing down the partition after each removal of said product.

DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 shows a perspective view of a refrigerated storage chamber with a track mounted flexible partition.

FIG. 2 shows a partially sectioned perspective view of details of the partition and track assembly and of the spring rollup means of FIG. 1.

FIG. 3 shows a partially sectioned view of a fixed flexible partition.

FIG. 4 shows a perspective view of a means for rolling up or rolling down a flexible partition.

DETAILED DESCRIPTION

FIG. 1 shows a refrigerated storage chamber 1 which is refrigerated by means of low-boiling liquefied gas refrigerant stored in storage tank 2. The liquid refrigerant is dispensed into the chamber through overhead spray means 3 in a manner well known to those skilled in the art, as for example described in Kane et al., U.S. Pat. No. 3,287,925, and the chamber is loaded with product (not shown) through doors 4. In this embodiment, the flexible partition comprises a one-piece rolled sheet partition 5 with a helical spring-operated roller 6 onto which the partition 5 may be rolled when not in use. The helical spring is shown as 13 in FIG. 2. Partition hold down means 7 comprising a recessed metal loop is provided to restrain the lowered partition from moving out of position. In addition,

tracks 8 are provided along either side of the storage chamber ceiling extending a substantial portion of the storage chamber length, such that the flexible partition may be set at virtually any desired location within the storage chamber thereby making it possible for the partition location to follow the remaining product toward the front of the storage chamber as the chamber is gradually unloaded. This "following partition" can be used in conjunction with shutoff valves 9, 10 and 11 in the spray means which are successively closed as the partition is moved further into the storage chamber, thereby terminating refrigerant flow to the storage chamber portion which no longer contains stored product. The main control valve for overhead spray means 3 is shown as valve 14 in FIG. 1.

FIG. 2 shows in greater detail the mating of U-shaped tracks 8 and roller 6. As can be seen in FIG. 2, the wheels of trolley 12 follow along the bottom edge of track 8 and thereby operably join roller 6 and track 8.

In FIG. 3 a fixed position flexible partition embodiment is shown. The flexible partition 5 should be gas impermeable, possess low thermal conductivity, should be readily cleanable, should not absorb moisture and should remain flexible at temperatures down to about −20° F. Rubberized or plasticized cloth as well as plastic sheet and cloth-plastic laminates are a few examples of suitable partition materials. The lower edge 15 of flexible partition 5 is preferably looped such that the partition can be weighted as, for example, by means of a metal chain 15*a*. Such a weight keeps the partition properly aligned nd wrinkle-free, but permits some deformation if required to accommodate irregularities in location of the stored product. In this embodiment a pull-tab handle 16 at intermediate elevation and a loop handle 17 at the lower end of partition 5 are preferably provided such that the partition may be quickly lowered from its rolled, stored position by an operator with maximum convenience. To prevent the partition from rolling in such a position that lower handle 17 does not remain available to an operator for pulling down the partition and to prevent the spring from complete unwinding at least one stop member is employed, in this embodiment stop members 18 are provided. When the partition is rolled up, these stops wedge against the ceiling or other structure member such that loop handle 17 remains hanging in a downward position within the operator's reach. Roller end brackets 19 are provided for attachment to the storage chamber sidewalls. Optional reinforcing members 20 which attach to both the sidewalls and ceiling of the storage chamber may be used to provide additional support for end brackets 19. To further reduce convection losses, a top closure member 21 may be provided in the plane of partition 5 between the ceiling and the partition upper end to prevent convective heat exchange across the partition in the space between roller 6 and the storage chamber ceiling. If such a ceiling panel is used, necessary shaping to accommodate the refrigeration piping or duct work would be provided.

It should be noted that the embodiment of FIG. 3 which uses a roller 6 having a helical metal spring 13 located therein for rolling the flexible partition onto the roller, may have conventional pawls or ratchet-type stop devices located within one end of the roller to hold it at any selected position, such as for an ordinary window shade. However, stops at the top and bottom position are all that are required. In addition, stop member 18 are provided, inter alia, to prevent complete unwinding of the roller spring when the partition is raised to the ceiling position.

While the helical spring 13 within roller 6 is a preferred means for raising flexible partition 5, a useful alternative as shown in FIG. 4, would comprise a small pulley 22 located at one end of roller 6 with an endless rope 23 wrapped at least once around pulley 22 sufficient to prevent slippage. Pulling on the appropriate strand of loop 23 would turn the roller and raise or lower the partition as desired. In this embodiment, suitable stop means such as a cleat fastened to the chamber wall to which rope 23 is fastened would be required to hold the rolled partition in the up, stored position.

Another alternative arrangement (not shown) for raising and lowering the flexible partition comprises a reversible electric motor installed within the roller with the shaft of the motor extending out of the roller end and fixed to the storage chamber wall. The motor could be so arranged such that operating an electric switch near the door of the storage chamber would raise or lower the partition. In another alternative embodiment (not shown) roller 6 could be attached to the lower end of flexible partition 5 which partition is rigidly affixed to the storage chamber ceiling and by means of appropriate rope and pulley mechanisms roller 6 could be rolled and unrolled and the partition raised and lowered thereby. In this embodiment the stored raised partition would be at the ceiling of the storage chamber as with the heretofore described embodiments.

In another alternative embodiment not shown in the drawings, the flexible partition is attached to the ceiling of the storage chamber but instead of utilizing a roller to raise, lower and store the partition, a rope may be woven back and forth through eyelets in the partition which extend the length of each side of the partition. Thus, by pulling on the two ropes simultaneously, the partition is raised to the ceiling and stored in a pleated configuration or by releasing the ropes the partition lowers to the floor of the storage chamber by gravity.

By their nature, flexible partitions of this invention are intended to reduce the adverse effects of long and/or frequent storage chamber door openings by reducing convective heat exchange between the storage chamber and the outside atmosphere. These partitions are best suited for dividing product loads of the same approximate temperature and are not intended to compartmentize a storage chamber such that temperatures maintained in one compartment are much different from temperatures maintained in adjoining compartments. In fact, nongastight rigid partitions which are unsuited to compartmentize a storage chamber such that temperatures maintained in one compartment are much different from those in adjoining compartments were thought to benefit greatly from their high heat conduction resistance. As a result, users were obliged to tolerate partition handling difficulties resulting from the rigidity and thickness of such partitions. However, it has been found that flexible partitions of this invention, despite their relatively higher thermal conductivity, unexpectedly perform comparably to the above-mentioned rigid partitions.

The partitions of this invention, as previously stated, have a width equal to the inside width of the storage chamber less a small amount sufficient to prevent binding to the partition between the chamber walls. Regardless of chamber inside width, this small amount ranges generally from about ½ to about 1½ inches.

A method for using the flexible partition of this invention takes into consideration the need to prevent convective heat exchange between the atmosphere within a product filled partitioned storage chamber compartment and the atmosphere outside the storage chamber. To accomplish this, the partition must be kept in a down position at all times when refrigerated product is stored within the compartment. The partition insulates against convective heat exchange and such partition should only be raised during the introduction or removal of refrigerated product. Typically, a method for refrigerating perishable products in a refrigerated chamber comprises placing product in the chamber beginning from the end opposite the access end and progressively stacking the product toward the access end of the chamber. As stacked product fills a compartment defined by a flexible partition, the partition is lowered and the stacking of product continues to the next partition location until all the product is deposited within the refrigerated chamber. If mechanical refrigeration means are employed, or if breathable liquefied refrigerant gas is employed, the refrigeration system can be left in operation during the loading of product. However, if liquid nitrogen is used as the refrigerant, the refrigeration system would be turned on only after all the product has been loaded into the storage

chamber. The method for unloading storage chambers is essentially the reverse of the method for loading storage chambers, that is, as a partition is no longer required to prevent convective heat exchange with a compartment within the storage chamber due to the removal of all the product therefrom, that partition would be raised to its ceiling storage means.

By using one or more partitions of this invention to divide a refrigerated storage chamber into two or more compartments, the amount of product exposed to atmospheric heat and humidity during door openings is reduced and the amount of refrigeration lost during such door openings can be reduced by as much as 25 percent. In addition to the other advantages of the flexible partitions of this invention, they are less likely to be damaged than rigid partitions during forklift loading or unloading operations.

EXAMPLE I

As an example of this invention a fixed, one-piece rolled fabric partition as shown in FIG. **3** was made using a heavy duty, metal, window-shade-type, roller 3 inches in diameter and 89 inches long. Flexible partition **5** was constructed of clear vinyl plastic, which remains flexible to −20° F., laminated to nylon scrim 12 inches by 12 inches count 840 denier 16 oz. per square yard. The partition was 88-inches wide by 96-inches long, and a galvanized steel chain was placed in looped edge **15** along the bottom of the partition. The storage chamber inside width was 90 inches. Pull tab **16** was 16-inches long, was constructed of a double thickness of curtain material and was located at about 48 inches from the bottom of the partition. Loop handle **17** was also 6-inches long and was constructed of a double thickness of curtain material. Stops **18** were of high density polyethylene measuring 2 inches long by 6 inches by ⅛-inch thick which were fastened back to back on each side of the partition. Brackets **19** were of die cast aluminum and were designed to mate with each end of the roller. Support members **20** were constructed of 12 gauge steel with a heavy galvanized coating. Ceiling panel **21** was constructed of rollup partition material mentioned heretofore and was 88-inches wide by 8-inches high. The ceiling panel was hemmed on all four sides and the top edge had a row of ¼-inch diameter grommets spaced on 8 inch centers.

Numerous partitions such as described hereinabove were installed for test in refrigerated trailers and trucks. It was found that total refrigeration requirements where reduced with the most notable effect being realized in trailer operations. A reduction of as much as 25 percent of liquid nitrogen refrigeration requirements in some trailer operations was experienced when the flexible partitions of this invention were used in combination with a spray header such as described in the discussion of valves **9**, **10** and **11** in FIG. **1**.

Experiments were run using a refrigerated frozen food truck having a chamber length of 18 feet, which truck made local deliveries. The chamber thermostat was set at about 31° F. and the outside temperature was about 80° F. The partition was placed at the chamber midportion and three test runs were performed. Average temperatures were sensed in the forward compartment, which is away from the storage chamber access end, and in the rear compartment. The first run was made without the partition being drawn down. It was found that prior to opening the storage chamber doors, the temperature differential from front to rear was 2° F. with the rear temperature being the higher temperature. After the storage chamber doors were opened for a set period of time and reclosed, the front to rear temperature differential was found to be about 2° F. and the rise in temperature of both the front and rear of the storage chamber was found to be 41° F. In a second run with the partition in a down and closed position, the initial front to rear temperature differential was found to be 2° F. and after the storage chamber doors had been opened for the same time as that of the first run, the doors were closed and the front to rear temperature differential was to be 14° F. The front temperature rise was 27° F. and the rear temperature rise was 41° F. In a third run with the partition in the down position, the initial front to rear temperature differential was 2° F. and after the doors had been opened and closed, the front to rear temperature differential was 17° F. with the front temperature rising 24° and the rear temperature rising 41°. Also, in the third run, 30 minutes after the compartment doors has been closed, with the partition down and with the spray headers for the rear compartment of the storage chamber turned off prior to door closing, it was found that the maximum front to rear temperature differential was 12° F. as compared with a maximum temperature differential for a nonpartitioned chamber of about 2° F. All outside ambient temperatures were approximately equal and the small differences were normalized in determining temperature differentials.

What is claimed is:

1. In apparatus for refrigerating perishable products including a storage chamber, a container for storing liquefied refrigerant gas, overhead spray conduit means in said storage chamber, and conduit means for dispensing cold fluid from said container to said overhead spray conduit means, the improvement comprising a thin flexible partition made of gas-impermeable sheet material disposed transverse to the storage chamber, having a length at least equal to about the inside height of the storage chamber, and a width equal to the inside width of the storage chamber less a small amount sufficient to prevent binding between the partition and the storage chamber sidewalls; and flexible partition storage means disposed near the ceiling of and transverse to the storage chamber such that the full length of the flexible partition can be drawn to the ceiling for storage by said storage means and withdrawn from said storage means for partitioning said storage chamber.

2. Apparatus as described in claim **1** wherein the partition sheet material comprises clear vinyl sheet plastic laminated to nylon cloth.

3. Apparatus as described in claim **1** wherein the partition storage means comprises a hollow roller, a spring disposed within said hollow roller and arranged to provide a force to roll said partition onto said hollow roller, and attachment means within and affixed to said storage chamber which attachment means provides support for both ends of said hollow roller.

4. Apparatus as described in claim **3** wherein the partition is looped at its lower edge and metal chain is disposed therein.

5. Apparatus as claimed in claim **2** having a handle of vinyl plastic sheet laminated to nylon cloth attached to the partition at a place suitable to accommodate the withdrawal and storage of said partition.

6. Apparatus as described in claim **3** wherein stop members are attached to the partition at its lower end, which stop members prevent the partition from withdrawing beyond a predetermined amount into the storage means.

7. Apparatus as described in claim **1** having the partition storage means positioned way from the storage chamber ceiling such that gas space exists therebetween wherein a top closure member is provided transverse said storage chamber and said gas space to impede gas convection through such gas space.

8. Apparatus as described in claim **1** disposed within a refrigerated storage chamber which chamber has holddown means provided which permit the partition lower portion, when drawn down, to be attached to the chamber.

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