July 12, 1938. W. J. MADDEN 2,123,678

REFRIGERATOR CONTAINER

Filed May 1, 1937 4 Sheets-Sheet 1

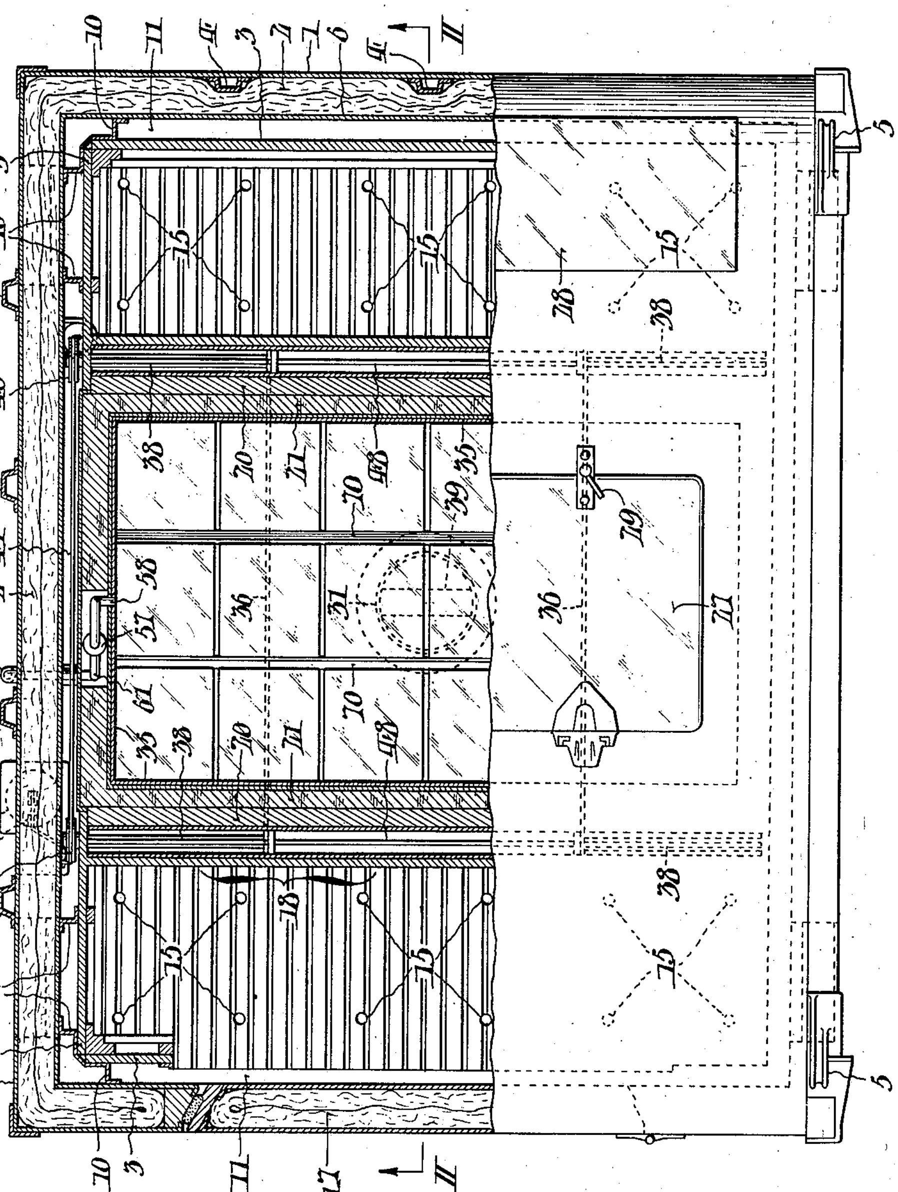

FIG. 1.

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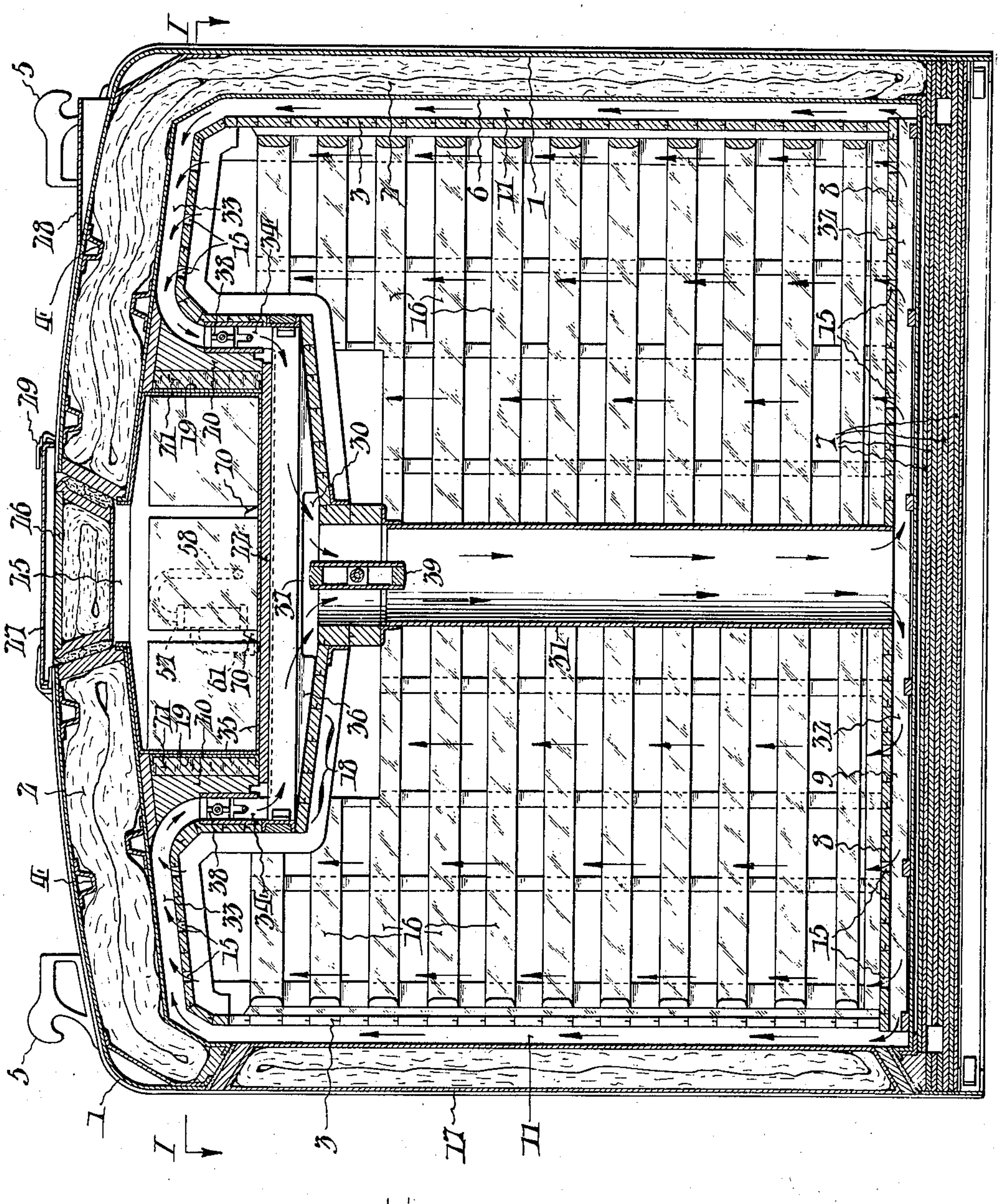

FIG. II.

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FIG. III.

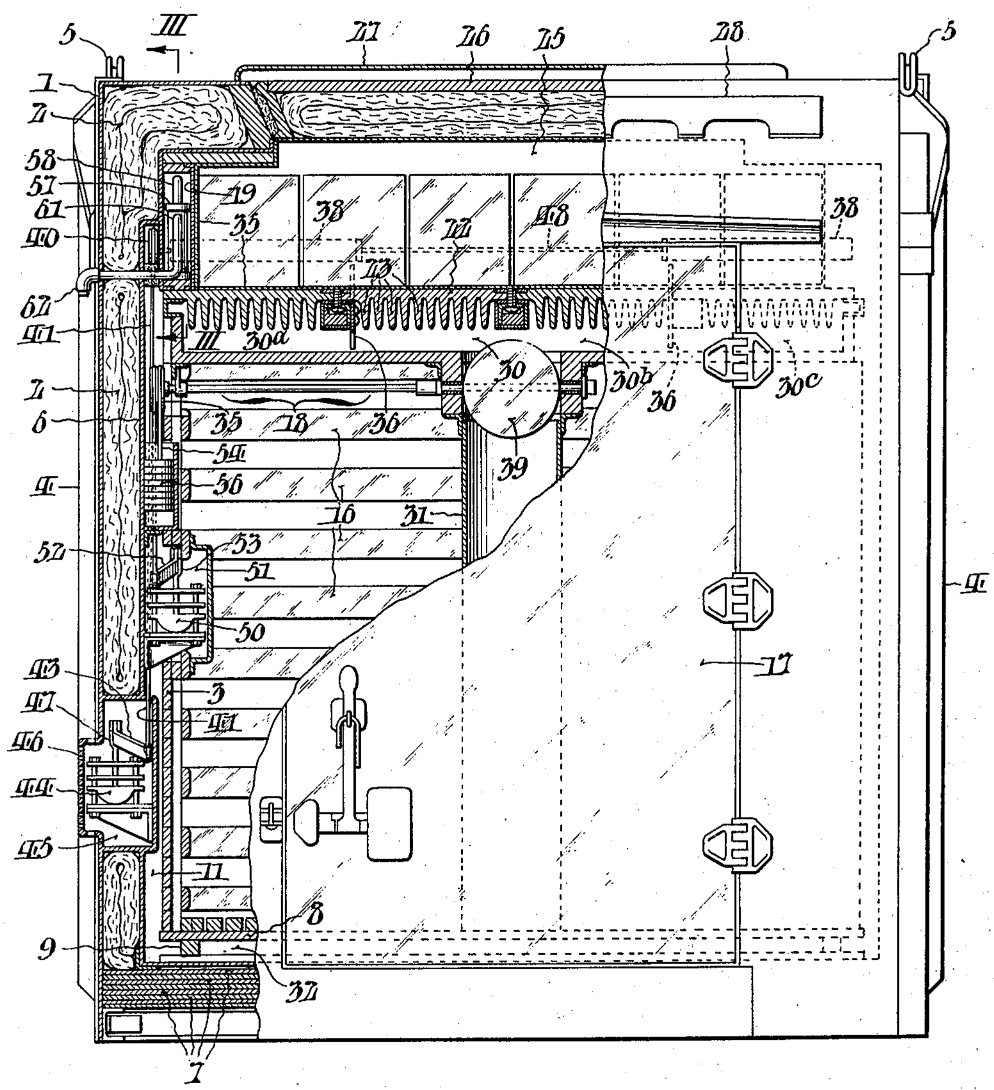

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FIG. IV.

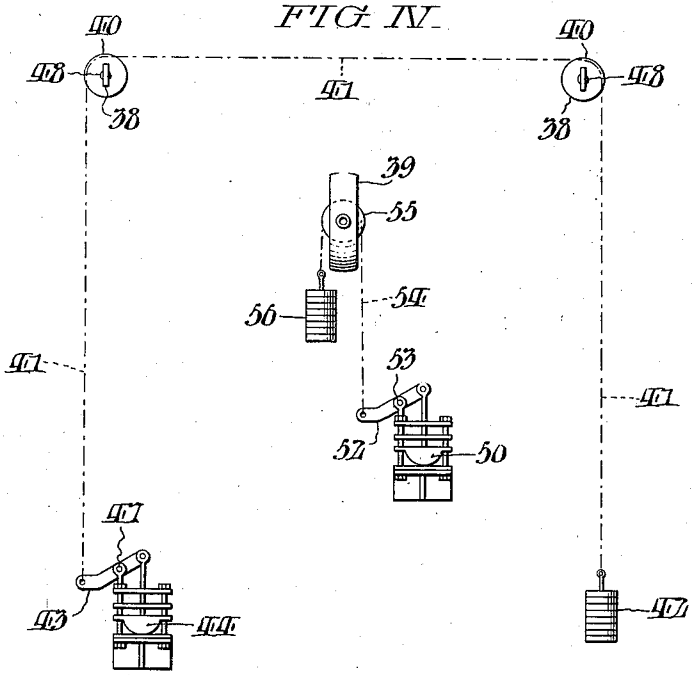


FIG. V.

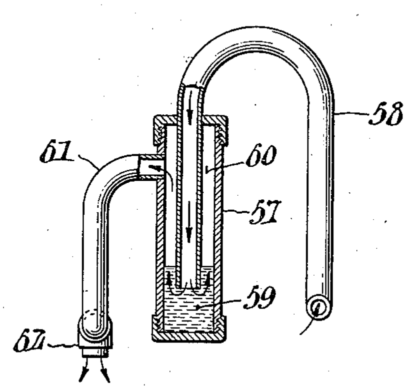
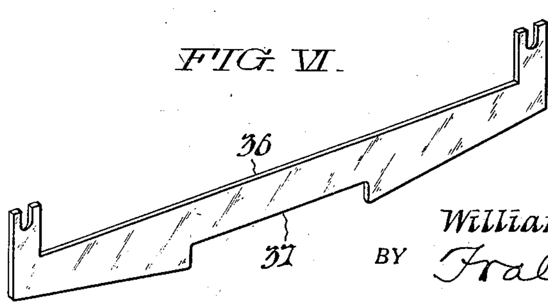


FIG. VI.



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2,123,678

REFRIGERATOR CONTAINER

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Application May 1, 1937, Serial No. 140,149

6 Claims. (Cl. 62—91.5)

My invention relates generally to refrigerator containers wherein solid carbon dioxide is used as the refrigerant medium, and more particularly to railway refrigerator containers of a type and size comparable to less-than-carload-lot shipping containers such as are now used by trucks and railroads for the transportation of passage freight.

One object of my invention is to provide a container generally similar to that described in Letters Patent No. 1,980,070, granted to me on November 6, 1934, but having improved efficiency and economy, and particularly characterized by its capacity to produce uniform and carefully controlled refrigeration of the lading over a comparatively long period of time, and under varying conditions as to outside temperatures, whereby perishable products may be transported for long distances without the necessity of recharging enroute.

Another object of the invention is to provide for temperature control in the lading-space of such a container by varying the effective area of surface contact between the air circulating within the container and a thermal transfer element through which heat is absorbed by the refrigerant medium.

A further object of the invention is to provide a thermal transfer element having such a form and such a coefficient of heat conductivity that it serves as a safeguard against excessively low temperatures while at the same time affording a sufficiently large and effective path of heat transfer to produce ample refrigeration of the lading for the purpose intended.

A further object of the invention is to provide in such a refrigerator container automatic temperature control mechanism whereof certain functions are responsive to the temperature within the lading space and other functions are responsive to the temperature of the atmosphere outside the container, and thus to take into account not merely the existing condition within the container at any particular moment, but also the exterior atmospheric condition which will eventually have an effect upon the rate of heat absorption.

Another object of the invention is to provide in such a refrigerator container an improved form of outlet for the discharge of the gas sublimated within the compartment for the refrigerant which will allow such gas to escape to the exterior atmosphere while sealing said compartment against the admission of air.

Still other objects and advantages characterizing my invention will become more fully apparent from the description hereinafter set forth of one embodiment or example thereof, having reference to the accompanying drawings. Of the drawings:

Fig. I represents a top plan view of a railway refrigerator container embodying my invention, with a portion thereof shown in horizontal cross section, as indicated by the lines I—I in Fig. II.

Fig. II represents a vertical cross-section of the container, taken centrally thereof, as indicated by the lines II—II in Fig. I.

Fig. III represents a front elevation at the door side of the container, with a portion of the front wall broken away to show the damper control mechanism.

Fig. IV represents diagrammatically the arrangement of damper controls of the container.

Fig. V represents a vertical section of a gas vent, taken as indicated by the arrows V—V in Fig. III; and,

Fig. VI represents a perspective view of one of the diaphragms of the container.

In the drawings, there is shown a container which in its exterior dimensions and form corresponds closely to the merchandise container described in my Patent No. 1,980,070, referred to above. Containers of this character are transported on railway cars, trucks or the like, and are generally arranged end to end in rows. The container comprises generally an outer metal casing 1, lined with insulating material 2, and an inner shell 3 spaced inwardly therefrom to afford air circulating passages surrounding the lading to be refrigerated.

The outer casing 1, in the form selected for illustration, is reinforced inwardly and outwardly with stiffening members 4 and is provided with lifting hooks 5 at its top corners, whereby it may be connected to an overhead hoist for the purpose of shifting it from car to truck, from car to stationary platform, or vice versa. While various materials may be employed for the insulating lining 2 of the outer casing 1, I prefer to utilize the substance known as "dry zero", and to maintain the lining in place by means of an inner metal casing 6. At the base of the container, layers 7 of insulating material, such as kapok or cork, are provided. The floor 8 upon which the lading is supported is spaced vertically above the insulating base material 7 by means of transversely extending beams 9. At the sides and ends of the container, the inner shell 3 is spaced inwardly from the casing 6 by means of vertically disposed members 10 which may take the form of Z-bars or channel bars. Between the inner shell 3 and the casing 6 vertical air passages 11 are thus provided.

Preferably the inner shell 3, including the floor 8 upon which the lading is supported, is made of fir blocks. Perforations 15 are well distributed over the top of the inner shell 3 as well as throughout the floor 8. The sides and ends of the inner shell 3 are imperforate. Within the lading space of the container, racks 16 of lattice construction may be provided for the purpose of protecting the inner shell 3 against damage due to impact with the lading. The racks 16 are shown as extending completely around the side and end walls, with the exception of the space where the hinged door 17 is located.

At the top of the container, and preferably centrally thereof, there is provided a bunker, comprehensively designated at 18, which is adapted to accommodate blocks of solid carbon dioxide. The refrigerant bunker 18 is suspended from the inner casing 6 of the container by means of vertical strips 19, and at its sides and ends it is insulated by outer layers 20 of fir and inner layers 21 of cork. Across the base of the refrigerant bunker 18, there is a thermal transfer element 22 which serves as the support for the cakes of solid carbon dioxide. Formed integrally with the thermal transfer plate 22 and depending therefrom are vertically disposed fins 23, shown most clearly in Fig. III, which afford a large heat conducting surface for the absorption of heat from the surrounding air.

Immediately above the refrigerant bunker 18 there is provided a filling hatch 25 normally closed by an insulated plug 26 and fitted with a hinged cover 27. In order to facilitate the operation of charging the refrigerant bunker 18 with cakes of solid carbon dioxide, I provide at the top of the container near the door equipped wall, a level platform 28. The cover 27 for the hatch 25 is hinged at the side opposite the platform 28. Accordingly, a man can stand with ease at the top of the container and operate the dogs 29 which secure the hinged cover 27 and gain access to the interior of the bunker 18.

The base of the refrigerant bunker 18, together with the inner shell 3, forms a cold air duct 30 into which the fins 23 project. From the cold air duct 30 there extends vertically downward a central cold air trunk 31 which passes through the lading space and the floor 8 and joins the air passage 32 beneath the floor. At the side and end walls of the container the spaces defined between the inner shell 3 and the surrounding casing 6 afford air passages 11 within which the relatively warm air may rise to the top of the container. Likewise at the top of the container the spaces defined between the inner shell 3 and the top of the casing 6 afford air passages 33 through which relatively warm air from the sides and ends of the container pass toward the refrigerant bunker 18. Additional vertical air passages 34 connect the horizontal air passages 33 with the cold air duct 30. It will thus be observed that there is provided a definite circulatory air system in indirect contact with the refrigerant, which system completely surrounds the lading to be refrigerated and is divided by the central air trunk 31 into a plurality of circuits through which air may take relatively short paths in its travel from the refrigerant bunker 18 to the base of the container and thence outward to the side and end walls and upward, and thence inward to the cold air duct 30. By reason of the perforations 15 provided at the top and bottom of the lading space, a portion of the air circulating in the container will find its way into the lading space and travel vertically upward through the lading.

The container as thus far described is substantially similar to the one shown in my prior patent referred to above, and the improvements and advantages differentiating the new container from the old one are hereinafter more specifically described.

Instead of employing a thermal transfer element of good heat conducting properties, such as aluminum or other metals, I utilize a thermal transfer plate 22 of carborundum or some like material having the heat conducting properties of an abrasive. The materials known as abrasives, of which carborundum will serve as an example, lie in the middle ground between good heat conductors and insulators. After many tests, I have found that materials of this group are particularly advantageous for the purpose of giving the desired heat transfer in a refrigerator container of the type here described. Carborundum, for example, has a co-efficient of heat conduction which is sufficiently low as to prevent the danger of freezing the lading or producing unduly low temperatures, and sufficiently high to afford an effective path of heat transfer between the lading and the refrigerant.

Inasmuch as abrasive materials are not impervious to carbon dioxide gas, there is provided a gas-tight lining 35 which surrounds the interior of the bunker 18 and includes a portion above the thermal transfer plate, as well as walls which extend vertically and join the inner metal casing 6. This lining 35 is preferably constructed of aluminum or the like. Wherever joints appear, they are welded or soldered in order to insure that the bunker 18 is gas-tight at all points. In order to prevent shifting of the blocks of carbon dioxide within the bunker 18, spacing ribs 70 are desirably provided at the base of the bunker, such ribs being shown most clearly in Figs. I and II.

The cold air duct 30 is divided by a number of diaphragms 36 into separate compartments. In the particular example illustrated, there are two diaphragms 36 which divide the cold air chamber into three compartments 30*a*, 30*b*, 30*c*. Each diaphragm 36, as shown most clearly in Fig. VI, consists of a flat plate conforming to the cross sectional shape of the interior of the cold air duct 30 and cut away as indicated at 37 at its central portion near the vertical air trunk 31. Relatively warm air is free to flow at all times through the horizontal air passages 33 and vertical air passages 34 into the central compartment 30*b* of the cold air chamber and from thence to the air trunk 31. At the ends of the outer compartments 30*a* and 30*c* of the cold air chamber, sectionalizing dampers 38 are provided. When these dampers 38 are closed, no air is admitted to the compartments 30*a* and 30*c*; and when the dampers 38 are opened, air may flow through these outer compartments toward the vertical air trunk 31. An additional damper 39 is disposed within the air trunk 31 at the top thereof.

For controlling the operation of the dampers 38 and 39, there is employed the system shown diagrammatically in Fig. IV. Associated with the sectionalizing dampers 38 are sheaves 40 over which passes a cable 41 having one end joined to a weight 42 and the other end joined to a lever 43 actuated by an outside thermostat 44. As shown most clearly in Fig. III, the outside thermostat 44 is desirably housed in a recess 45 in one wall of the container and protected by a louver 46. This thermostat 44 is responsive to the temperature of the atmosphere outside the container, and as such temperature varies the lever 43 moves about its pivot 47, causing the cable 41, under the influence of the weight 42 to operate simultaneously all of the sectionalizing dampers 38 by movement of the sheaves 40 on the shafts 48 connected to the dampers 38. The central damper 39, located at the top of the air trunk 31 is operated by a thermostat 50 which is disposed inside the container and within a protective casing 51 shown most clearly in Fig. III. A lever 52 pivoted at 53 connects the inside thermostat 50 with a cable 54 which passes over a sheave 55, associated with the damper 39 and which is connected at its end with a weight 56, all as clearly shown in Fig. IV.

From the above description it will be observed that the operation of the sectionalizing dampers 38 is responsive to the outside atmospheric condition, and the operation of the central damper 39 in the air trunk 31 is responsive to the prevailing temperature within the lading space of the container. The advantage of such system of thermostatic control is that it takes into account not merely the condition which exists within the container at any particular moment, but also the exterior atmospheric condition which will eventually have an effect upon the rate of heat absorption. Thus, for example, if the temperature within the lading space has been reduced to the desired point and the sectionalizing dampers are closed, and the container is thereafter moved to a position where it is subjected to the rays of the sun or warmer outside atmospheric conditions, the ultimate effect of this change of outside atmosphere is anticipated. The outside thermostat 44 functions to open the dampers 38 and permit air to flow through the outer compartments 30*a* and 30*c*, as well as through the inner compartment 30*b* of the cold air chamber. In this manner, provision is made for varying the effective area of contact between the thermal transfer plate 22 and the air circulating through the duct therebeneath, and thus to control the heat transfer from the lading to the refrigerant.

For the purpose of permitting the discharge of gas from the bunker 18, while preventing the admission of air into the bunker, there is provided a trap 57. This trap 57 is conveniently located within the bunker and near one end thereof at the position shown in Fig. III. A more detailed showing of this device may be seen in Fig. V. Gas from the bunker 18 enters one end of an inverted U-shaped tube 58, the other end of which is submerged in a liquid solution 59. The solution 59 is made up of a non-freezing material such as Zerone or Prestone. Surrounding the discharge end of the tube 58 there is an annular passage 60 near the top of which an outlet tube 61 is provided. The outlet tube 61 penetrates through the side of the container and terminates in an elbow 62, shown most clearly in Fig. III. The gas of sublimation formed within the bunker 18 passes through the inverted U-shaped tube 58 and then bubbles through the anti-freezing solution 59, from whence it passes through the annular passage 60 in the trap 57 to the outlet tube 61. In an obvious manner this provides for the intermittent escape of carbon dioxide while preventing admission of air. The device is such that it can take care of varying conditions and varying rates of sublimation, and hence involves an advantage over the ordinary vent which is customarily provided for this purpose and which is incapable of functioning efficiently under all different conditions.

While I have described my invention in some detail and with reference to a specific embodiment or example thereof, it will be apparent, especially to those skilled in the art, that various changes may be had in the form of the container, and that certain features of the invention may at times be used to advantage without a corresponding use of other features, all without departing from the spirit of my invention as defined in the annexed claims.

Having thus described my invention, I claim:

1. In a refrigerator container, a bunker for solid carbon dioxide refrigerant, a duct for circulating air around the lading and into proximity with said bunker, a thermal transfer element disposed between said bunker and duct, and thermostatically controlled means for varying the effective area of contact between said thermal transfer element and the air circulating in said duct.

2. In a refrigerator container, a bunker for solid carbon dioxide refrigerant, a duct for circulating air around the lading and into proximity with said bunker, a thermal transfer element disposed between said bunker and duct, and thermostatically controlled sectionalizing dampers for varying the effective area of contact between said thermal transfer element and the air circulating in said duct.

3. In a refrigerator container, an outer casing, a bunker for solid carbon dioxide refrigerant near the roof of said casing, an inner shell enclosing the lading and defining with the walls of said casing a passage for the circulation of air around the lading, said passage leading to a duct extending beneath said bunker, a thermal transfer element disposed between said bunker and duct, and thermostatically controlled sectionalizing means for varying the effective area of contact between said thermal transfer element and the air circulating in said duct.

4. In a refrigerator container, a bunker for solid carbon dioxide refrigerant having a gas-tight lining of a material impervious to carbon dioxide, a duct for circulating air around the lading and into proximity with said bunker, a thermal transfer element separating said duct and the lining of said bunker and having integral projecting fins substantially filling said duct, said transfer element and fins being of a material having the heat conducting properties of an abrasive, and sectionalizing means for varying the effective area of contact between said thermal transfer element and the air circulating through said duct.

5. In a refrigerator container, a bunker for solid carbon dioxide refrigerant having a gas-tight lining, a duct for circulating air around the lading and into proximity with said bunker, a thermal transfer element separating said duct and the lining of said bunker and having projecting fins substantially filling said duct, said transfer element and fins being of a material having the heat conducting properties of an abrasive, and sectionalizing means for varying the effective area of contact between said thermal transfer element and the air circulating through said duct, including diaphragms subdi-

viding said duct and individual dampers associated with certain of said subdivisions.

6. In a refrigerator container, a bunker for solid carbon dioxide refrigerant, passages for circulating air around the lading, then beneath said bunker and then returning the air to the lading space, a thermal transfer element disposed between said bunker and the passage beneath it, means for varying the effective area of contact of said thermal transfer element and the air in the passage beneath the bunker including a thermostat responsive to the temperature of the atmosphere outside the container for controlling such effective area, and additional means for varying the volume of air circulating in said return passage, including a thermostat responsive to the temperature of the lading space within the container for controlling such volume of air.

WILLIAM J. MADDEN.