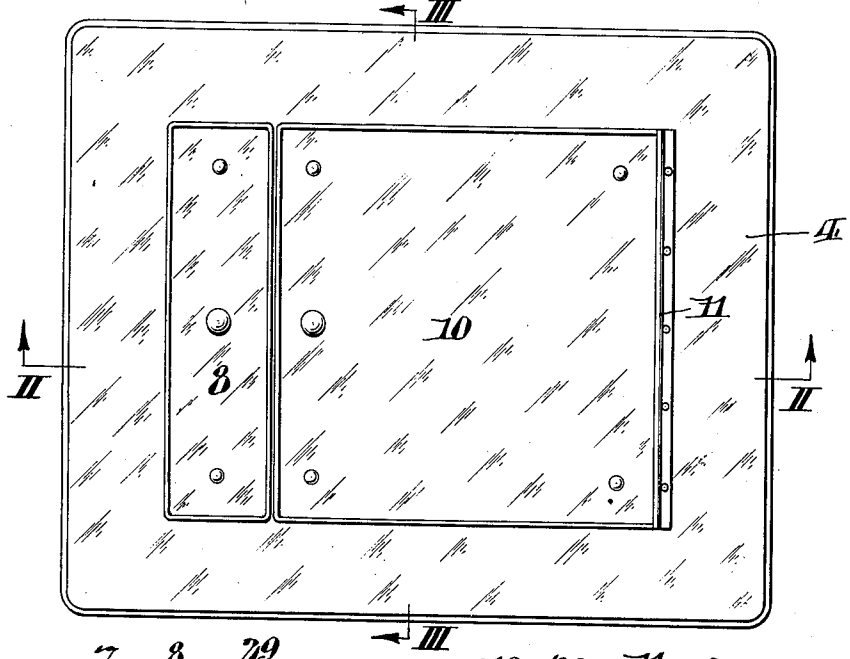
Oct. 4, 1932. C. E. BONINE 1,880,735

REFRIGERATOR

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FIG. I.



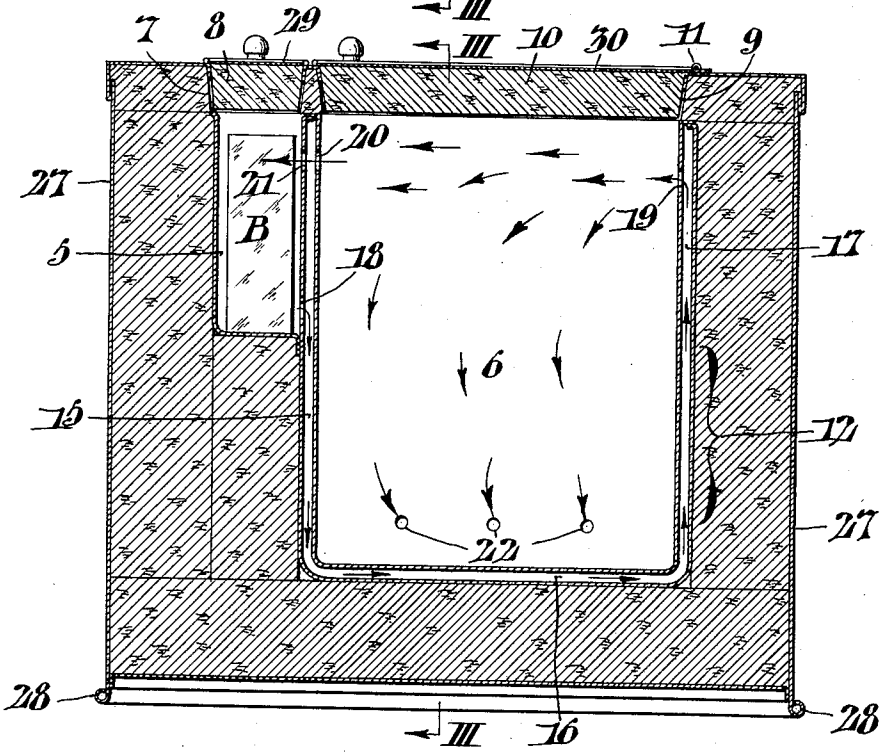


FIG. II.

WITNESSES

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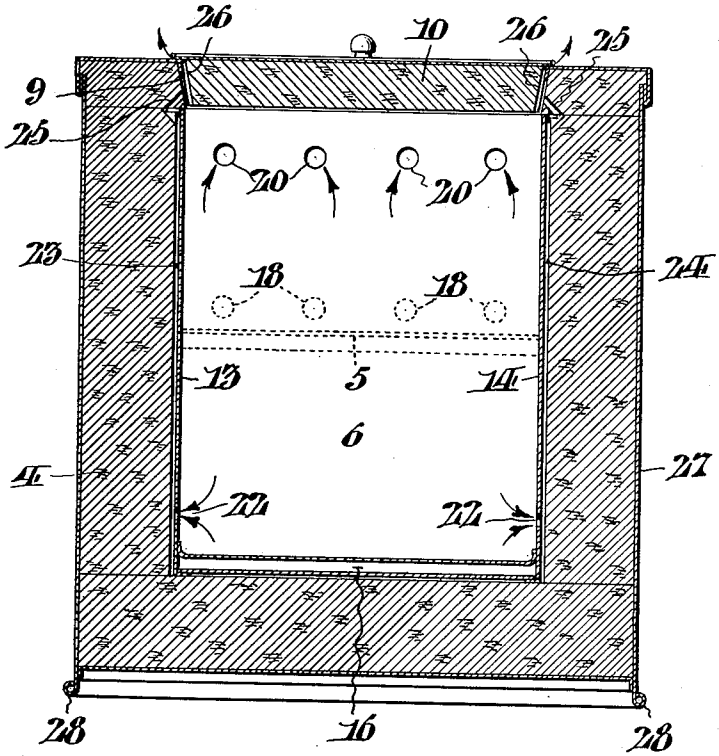
ATTORNEYS.

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REFRIGERATOR

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FIG. III.



WITNESSES

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REFRIGERATOR

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FIG. IV.

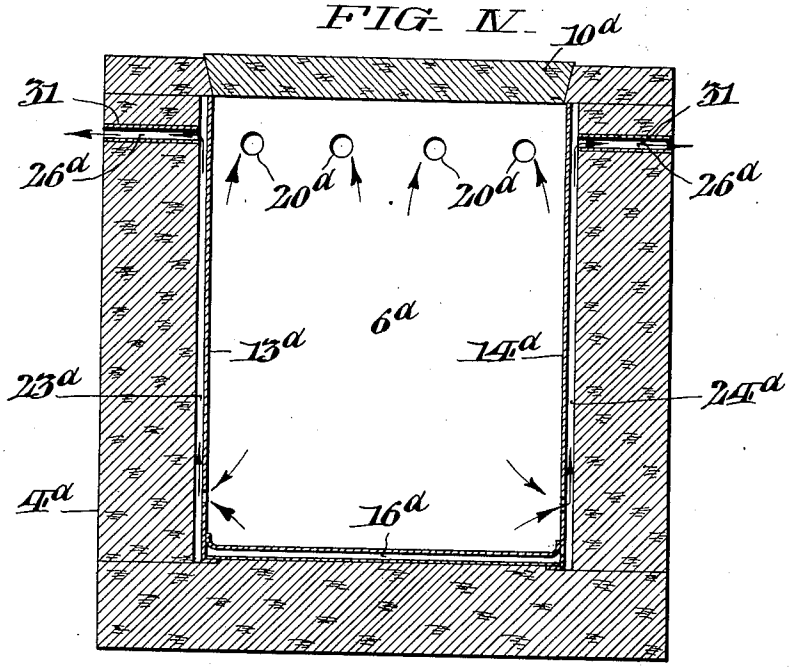


FIG. V.

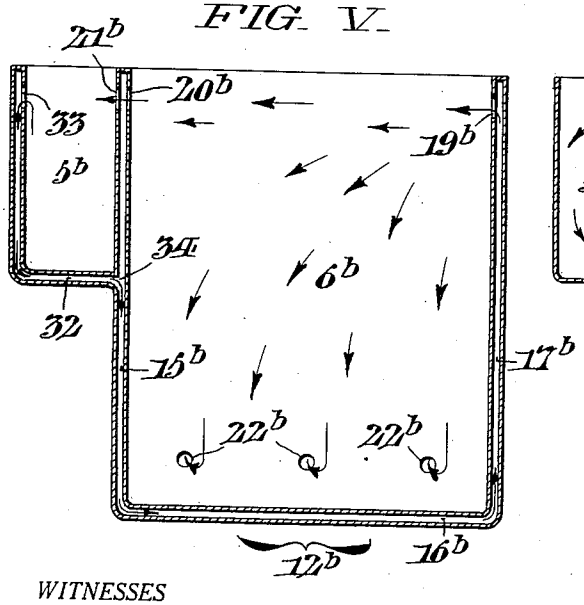
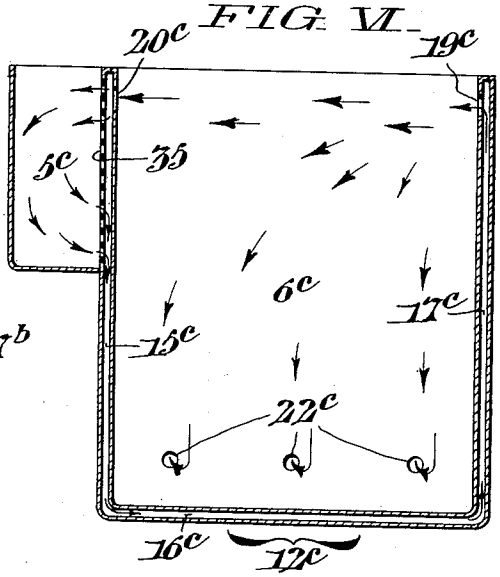


FIG. VI.



WITNESSES

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Oct. 4, 1932. C. E. BONINE 1,880,735

REFRIGERATOR

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FIG. VII.

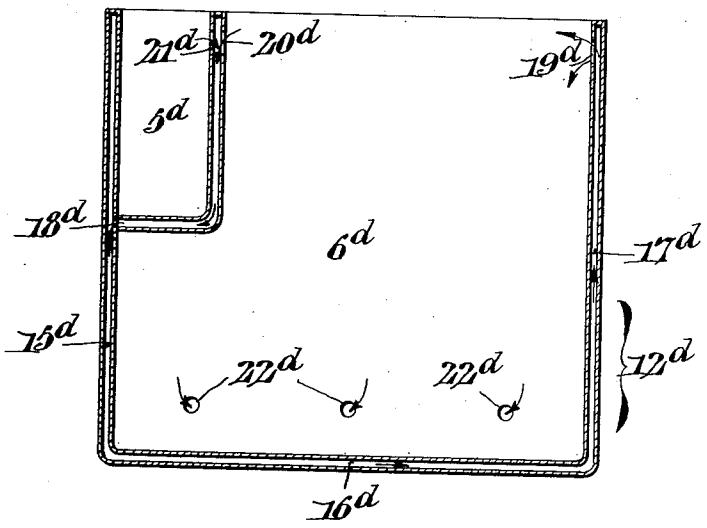


FIG. VIII.

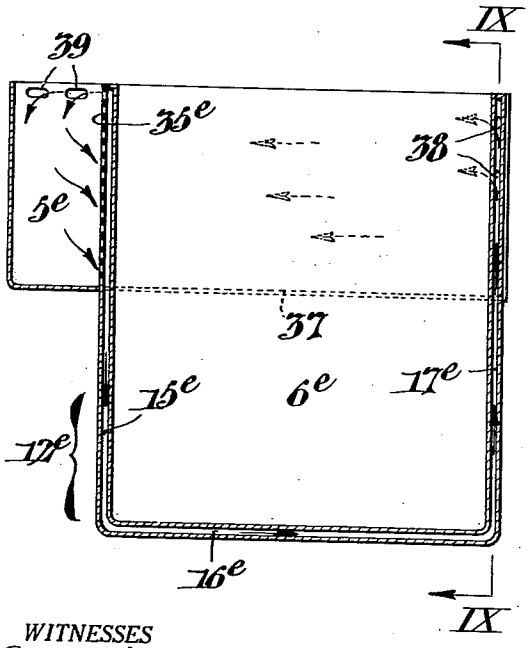
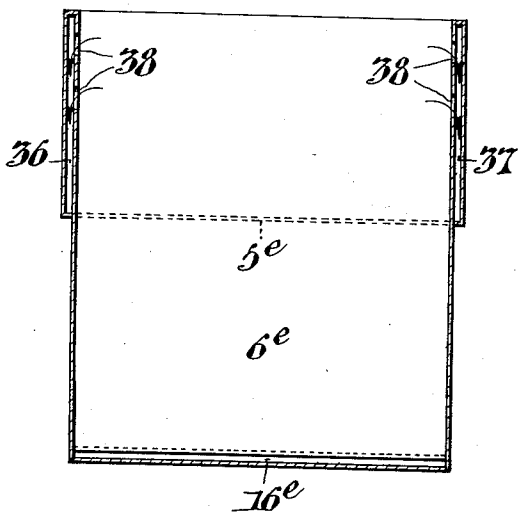


FIG. IX.



WITNESSES

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REFRIGERATOR

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FIG. XII.

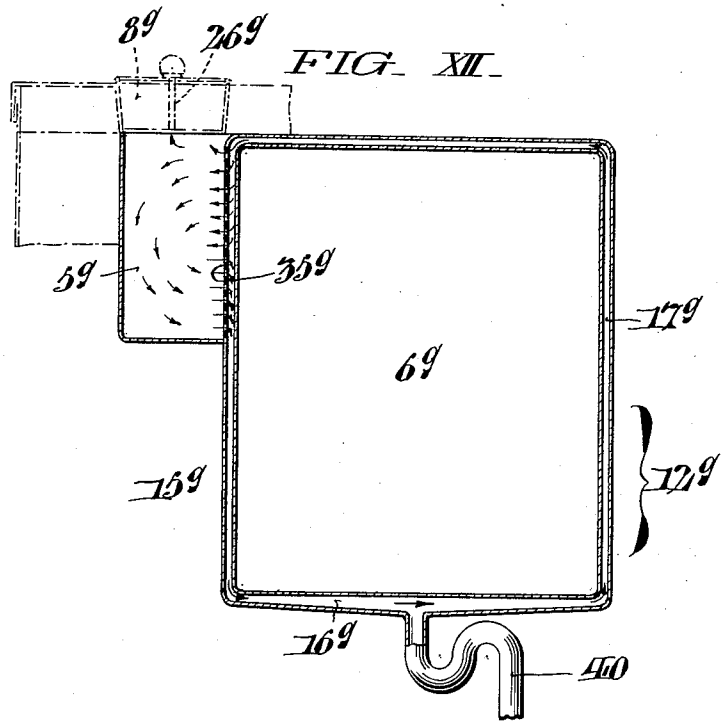


FIG. X.

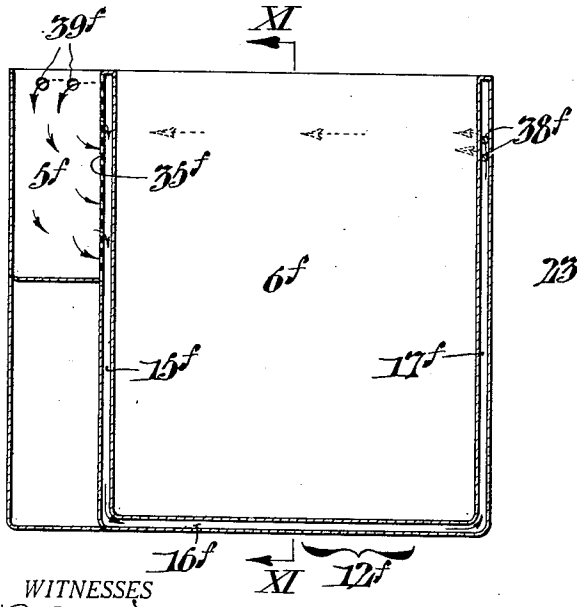
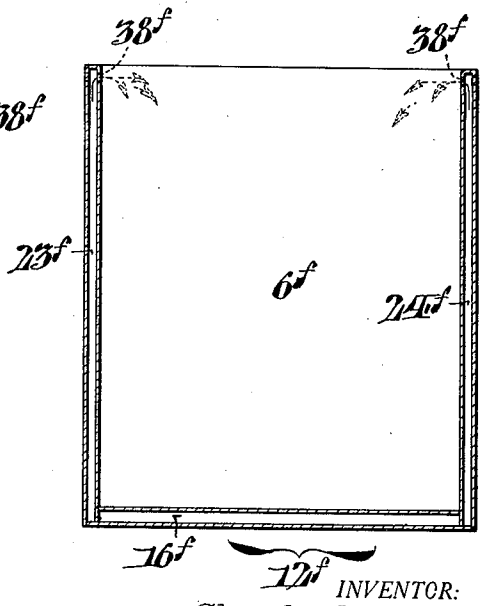


FIG. XI.



WITNESSES

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Patented Oct. 4, 1932 1,880,735

UNITED STATES PATENT OFFICE

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REFRIGERATOR

Application filed July 17, 1929. Serial No. 378,842.

This invention relates to refrigerators, and has more particular reference to refrigerators of a type intended for use of solid carbon dioxide and the like.

Solid carbon dioxide, as is well known, is a powerful refrigerant with a latent temperature in the neighborhood of 114° F. below zero, and cannot therefore be used after the manner of ordinary ice in refrigerators as commonly constructed without danger of excess freezing and spoliation of the articles or products undergoing preservation.

The main object of my invention is to overcome the drawbacks above pointed out through provision of a refrigerator structure wherein the influence of the solid carbon dioxide is moderated to such an extent that a sufficiently cool even chilling temperature is maintained for preservation of the articles being refrigerated more economically and efficiently than possible with the use of ordinary ice.

Other objects and attendant advantages of this invention will appear in the course of the description following of the typical embodiments shown in the drawings whereof Fig. I is a plan view of my improved refrigerator in one form.

Fig. II is a sectional view of the structure taken as indicated by the arrows II—II in Fig. I.

Fig. III is a cross section taken as indicated by the arrows III—III in Figs. I and II.

Fig. IV is a view like Fig. III showing a modified constructon of the refrigerator.

Figs. V and VI are sectional illustrations showing, more or less diagrammatically, further modifications which differ but slightly from the form of my invention shown in Figs. I–III.

Figs. VII and VIII are views similar to Figs. V and VI showng two other modifications.

Fig. IX is a cross sectional view taken as indicated by the arrows IX—IX in Fig. VIII.

Fig. X is a view corresponding to Fig. VIII illustrating an alternative construction of the form of refrigerator shown in the latter figure.

Fig. XI is a cross section taken as indicated by the arrows XI—XI in Fig. X; and

Fig. XII shows an additional alternative form of refrigerator generally resembling the modification of Fig. VIII.

Referring first to Figs. I–III, the form of my improved refrigerator therein shown comprises a casing 4 made from cork or a suitable thermo-insulating compositon with a chamber 5 therein for a block B of solid carbon dioxide or the like, as well as a comparatively larger chamber 6 for the articles or materials which are to be refrigerated. The chamber 5 is accessible from the top of the structure through an opening 7 fitted with a removable lift cover 8. The refrigerating chamber 6 is likewise accessible through a top opening 9 which is closed by a lid 10 with a hinged connection at 11. In the present instance, the two chambers 5, 6 are defined by a box-like inset 12 made from sheet metal to fit the hollow of the thermo insulate casing 4 whereof the walls are amply thick to efficiently preclude thermal losses by radiation. In practice the chamber 5 is preferably made just large enough to conveniently hold a commercial size block B of the refrigerant, and to about half the depth of the refrigerating chamber 6. For convenience, the side walls 13, 14 of the metallic inset 12 may be common to both the chambers 5, 6, said side walls being of single thickness throughout, as shown in Fig. III. The end walls and bottom of the refrigerating chamber 6 are however made double and the thicknesses separated by a substantial interval with provision of coextensive communicating passages 15, 16, 17.

In the operation of the refrigerator of Figs. I–III, the cold heavier-than-air gas released incident to sublimation of the solid carbon dioxide flows from the bottom of the chamber 5 through openings 18 (Fig. II) in the outer portion of the contiguous end wall of the refrigerating chamber 6 into the passage 15, then downward in said passage, then horizontally through the passage 16 along the bottom of the chamber 6, and finally upward through the passage 17 in the right hand end wall wherefrom it enters the chamber 6 at the top through openings

19 in the inner thickness of the last mentioned end wall. As the gas descends in the chamber 6 and passes about the articles or products therein, thermal interchange takes place with rise of the stratas of the gas incidentally warmed which find their way back into the chamber 5, through aligned openings 20, 21 in the two thicknesses constituting the left hand end wall of the chamber 6. In contacting with the solid carbon dioxide block B, the returned warmed gas is obviously lowered in temperature and thereby prepared to retrace the same course which it had previously followed. A continuous circulation is in this way maintained within the refrigerator between the chambers 5, 6 to the end that refrigeration is effected by the liberated gaseous carbon dioxide and not through direct influence of the solid refrigerant itself, which, it will be noted, is isolated by virtue of interposition of the vertical gas flow passage 15 between said chambers. After the refrigerating process has proceeded to the point where the products within the chamber 6 take on the temperature of the cold gas, the rate of circulation within the refrigerator naturally decreases with maintenance of a uniformly cold more or less static atmosphere about said products. This condition operates as a check on the sublimation of the refrigerant and in turn greatly enhances the economical operation of the refrigerator. Concurrently with the events above related, a certain proportion of the gas in the refrigerating chamber 6 escapes through openings 22 near the bottom of the latter in the opposite side walls 13, 14 and into clearances 23, 24 which are coextensive with said side walls, see Fig. III. From these clearances 23, 24 the gas eventually exhausts into the external atmosphere by way of grooves 25, 26 respectively in the casing 4 and the hinged cover 10. By reason of this provision it will be seen that, in addition to circulation of the gas between the chambers 5 and 6, a circulation is maintained around the side walls 13, 14 of the refrigerating chamber to cool them, as well as around the opposite end walls and bottom of said chamber. It is also important to note that the openings 22 are fewer in number and smaller than the openings 20, 21 so that most of the refrigerating gas is repeatedly circulated between the chambers 5, 6 in the manner previously explained. For better protection of the thermo-insulation 4, I prefer to cover the casing 4 with a sheathing 27 of sheet metal, forming at the same time a depending peripheral foot or base flange 28 by which the casing proper is sustained at an elevation and a dead air pocket afforded beneath said casing to minimize losses by radiation at this region. The cover 8 and the lid 10 are likewise encased in sheet metal as at 29, 30, respectively, for protection of the insulating material from which they are made.

The modification of Fig. IV is similar to the first described embodiment except as to the provisions made for escape of the carbon dioxide gas from the refrigerator. In this case outlets 26*a* are formed in the side walls of the insulate casing 4*a* near the top, which outlets, as shown, lead horizontally from the clearances 23*a*, 24*a* to the exterior and which are defined by tubes 31 of glass or the like. Such construction assures against possible clogging of the outlets through disintegration of the cork or composition constituting the casing 4*a*. Here, as in the description of other modifications following, the parts which are not specifically mentioned, but which correspond to those of the first embodiment, are identified by the same reference numerals previously employed with addition of different letters of the alphabet.

Fig. V shows an alternative form of metallic inset 12*b* in which the end and bottom walls of the chamber 5*b* are made double with incident formation of a passage 32 having communication with said chamber 5*b* near the top through apertures 33, said passage leading directly into the interval 15*b* along the contiguous side wall of the refrigerating chamber 6*b* through a port 34. Accordingly, gas liberated from the solid carbon dioxide in the chamber 5*b* is obliged to pass first around said chamber before making its circuit about and through the refrigerating chamber 6*b* as in the first embodiment.

In the modification of Fig. VI, that portion of the outer side wall of the refrigerating chamber 6*c* which is common to the chamber 5*c* for the refrigerant, is fashioned from wire gauze or perforated metal conventionally indicated at 35. In all other respects the inset 12*c* is like the inset 12 of Figs. I–III as will be readily apparent by comparison. The advantage of the present construction is that, by reason of the greater number of openings in the partition 35, freer circulation of gas is permitted through the chamber 5*c* as is manifested by the arrows in Fig. VI, and clogging of the flow passages by shifting of the solid carbon dioxide block as might happen in the inset 12 of Fig. II where the ports or apertures 18, 21 are fewer in number, prevented.

In Fig. VII, the chamber 5*d* for the solid carbon dioxide is included within the confines of the refrigerating chamber 6*d* to the end that the inset 12*d* is devoid of external projections. As shown, flow channels are formed around both chambers 5*d*, 6*d*, and circulation of gas over the course indicated by the arrows is determined by the apertures 18*d*, 19*d*, 20*d*, 21*d* and 22*d* in the partitioning.

Figs. VIII and IX show a modification suitable to the refrigeration of fruits and the like where direct contact of carbon di-

oxide gas—as in the previous embodiments with the articles or products undergoing refrigeration—is prohibitive if spoliation or discoloration is to be prevented. Accordingly, the refrigerating chamber 6*e* is entirely isolated from the chamber 5*e* containing the solid carbon dioxide; and channels 36, 37 are provided for return of the gas after having traversed the hollow end wall 15*e*, and bottom 16*e*, and opposite end wall 17*e* of said chamber 6*e*. For structural convenience, the return channels 36, 37 are made to a depth corresponding to that of the chamber 5*e*; and ports 38 and 39 are allocated at proper points in the partitioning to predetermine circulation as described and as indicated by the arrows in Figs. VIII and IX.

In Figs. X and XI the return channels 23*f*, 24*f* are made coextensive in depth with the refrigerating chamber 6*f*. Otherwise, the construction and operation of this modification is exactly the same as that described in connection with Figs. VII and VIII.

The modification of Fig. XII is suitable for household refrigerators and the like in which, for the sake of convenience, access must be had to the refrigerating chamber through a side door opening instead of from the top as in the other modifications of my invention. To this end, the top, bottom and opposite end walls of the chamber 6*g* are made hollow for circulation of the gas around it after the manner indicated by the arrows. Excess gas is permitted to escape through a suitable vent 26*g* in the cover 8*g* for the chamber 5*g*; and a trap 40 is provided at the bottom of the unit for escape to the exterior of condensation of any water vapor which may find its way into said chamber. It is of course to be understood that the chamber 5*g* may be constructed with double sides and bottom as shown in Fig. V.

As exemplified herein, my invention is susceptible to many variations and therefore adaptable to any special requirements which must be met in practice. It is to be particularly remarked however that the principle of operation is the same in all the forms which have been discussed in detail. Obviously the principle set forth may be embodied in refrigerators which are portable for shipment of perishable commodities, as well as in refrigerators intended for domestic and other purposes. The appended claims are accordingly to be broadly construed with the above considerations in mind.

Having thus described my invention, I claim:

1. In a refrigerator of the character described, a thermo insulated casing affording a chamber for solid carbon dioxide; a chamber for the articles being refrigerated; passages determining flow of the cold gas liberated incident to sublimation of the solid carbon dioxide, down along one end of the refrigerating chamber, across the bottom of the same and up along the opposite end previous to entering said refrigerating chamber at the top for descent about the articles in said refrigeraing chamber; and passages to conduct the gas from the bottom of said refrigerating chamber upward along the outer faces of its opposite side walls before being permitted to escape from the refrigerator.

2. In a refrigerator of the character described, a thermo-insulated casing affording a chamber for solid carbon dioxide; a chamber for the articles being refrigerated; passages determining circulation of the cold gas liberated incident to sublimation of the solid carbon dioxide, downward along one end of the refrigerating chamber, across the bottom and up the opposite end, then through said refrigerating chamber and back into the chamber containing the refrigerant; and passages through which proportionate amounts of the circulating gas are concurrently conducted from near the bottom of the refrigerating chamber and upward along the outer faces of its opposite sides previous to release from the refrigerator into the outside atmosphere.

In testimony whereof, I have hereunto signed my name at Philadelphia, Pennsylvania, this 13th day of July, 1929.

CHARLES E. BONINE.