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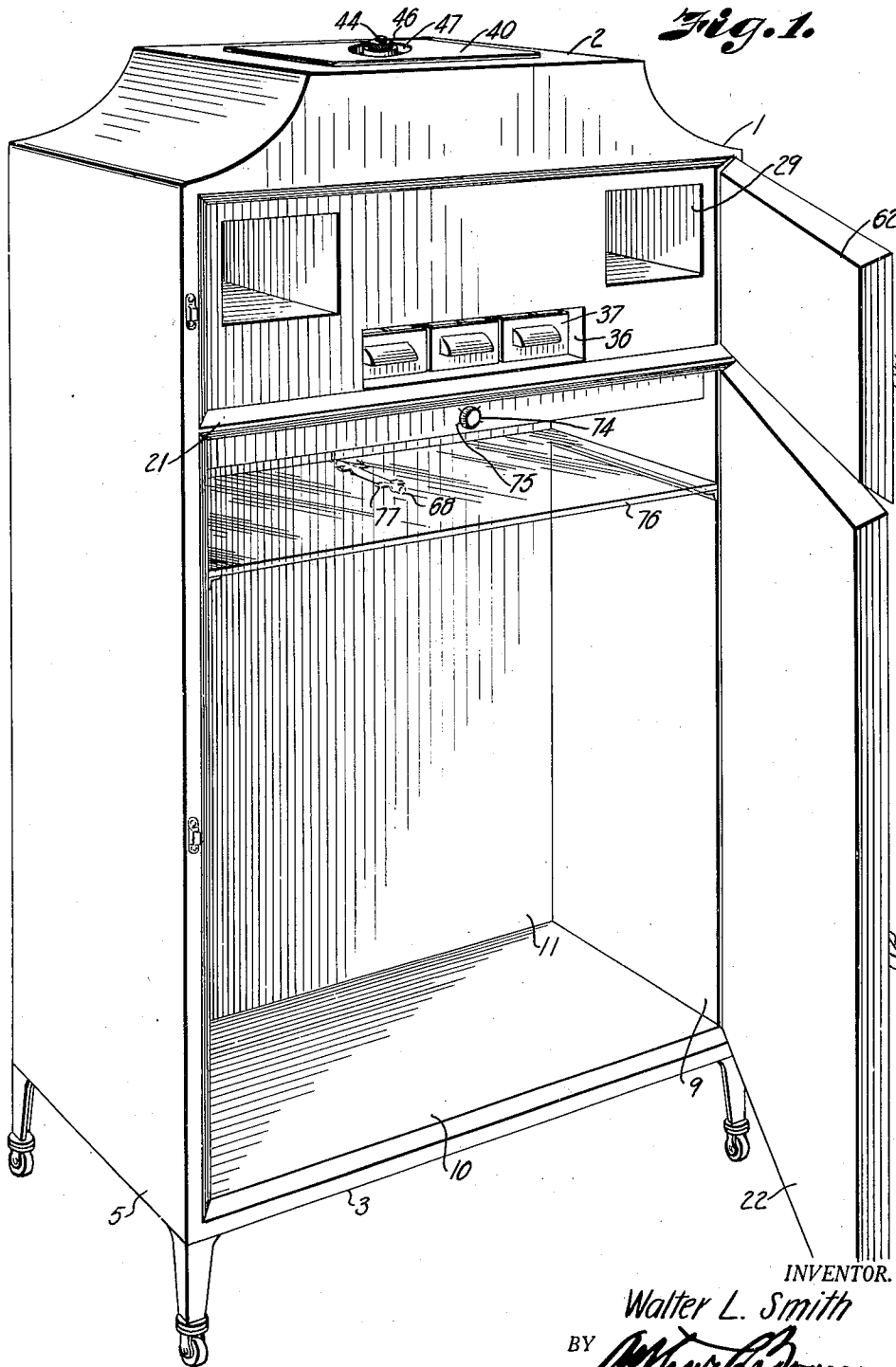
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1,965,205

METHOD OF AND APPARATUS FOR REFRIGERATION WITH SOLID CARBON DIOXIDE

Filed March 12, 1932

3 Sheets-Sheet 1



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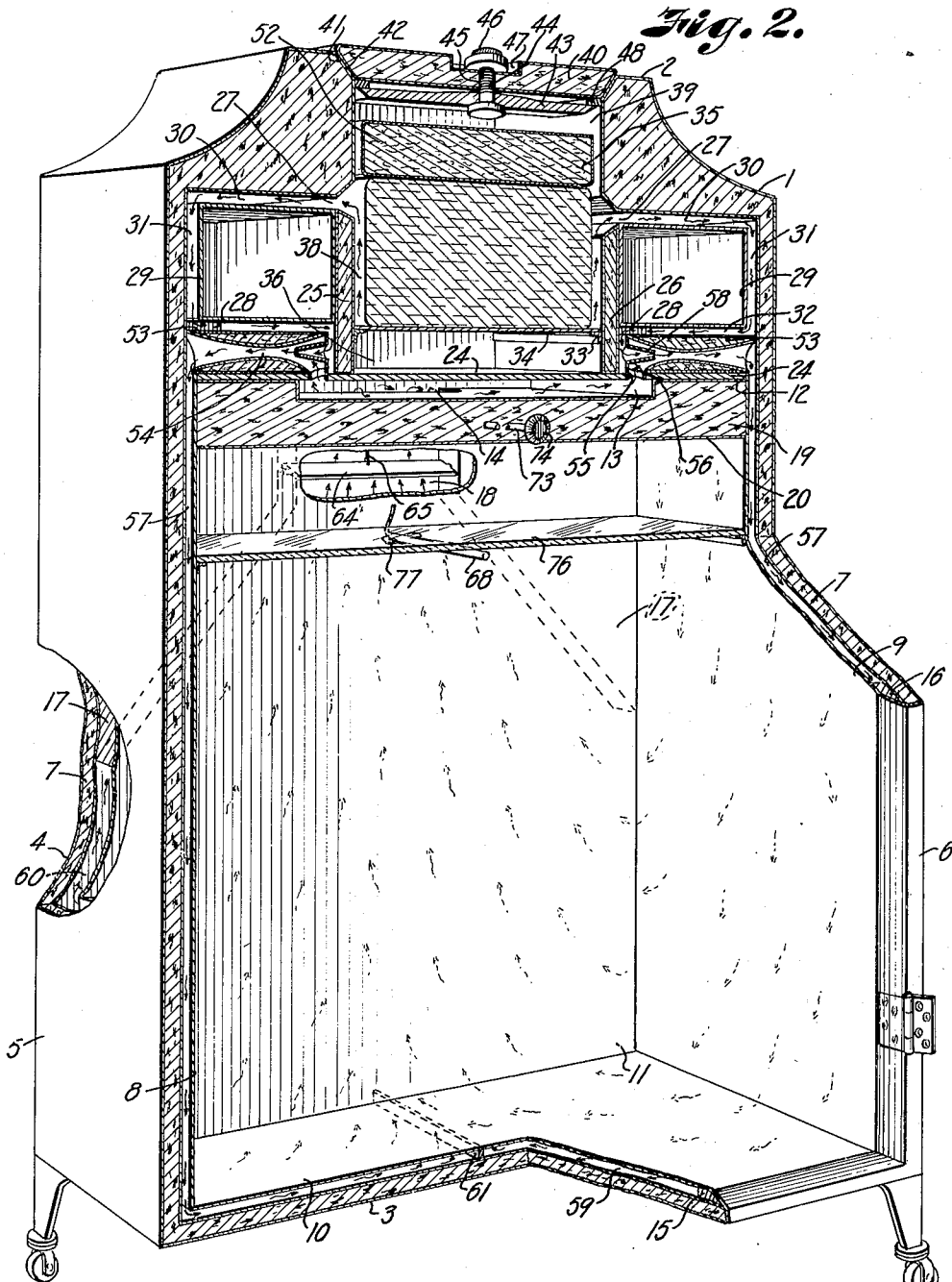
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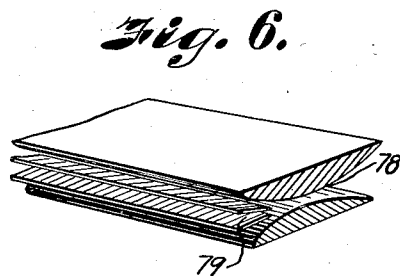
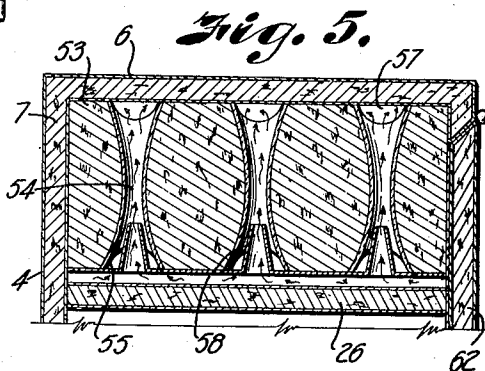
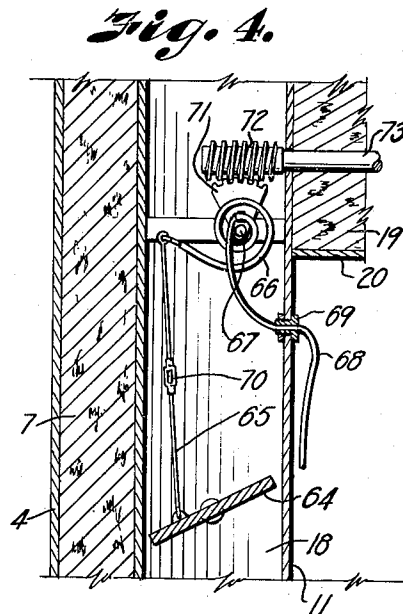
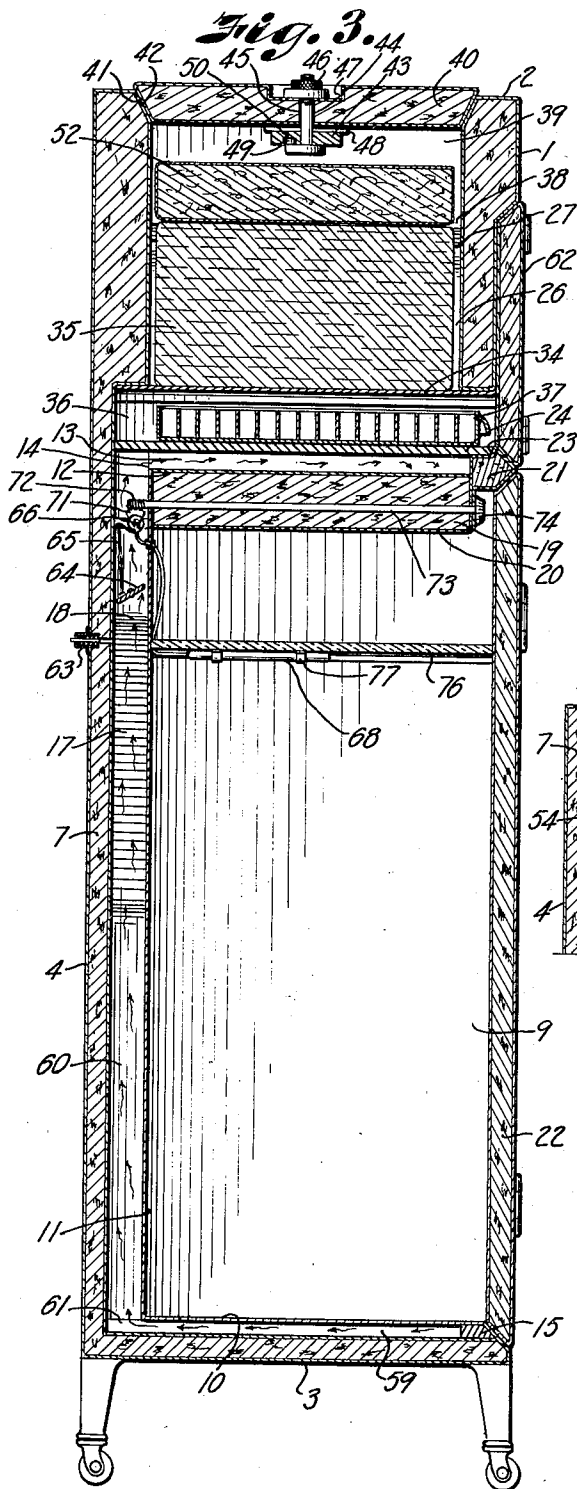
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METHOD OF AND APPARATUS FOR REFRIGERATION WITH SOLID CARBON DIOXIDE

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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METHOD OF AND APPARATUS FOR REFRIG-
ERATION WITH SOLID CARBON DIOXIDE

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Application March 12, 1932, Serial No. 598,413

11 Claims. (Cl. 62-91.5)

My invention relates to a method of and apparatus for refrigeration with solid carbon dioxide (dry ice).

Carbon dioxide in solid form reverting to gas at approximately 110° below zero and to approximately 700 times its solid volume per cubic inch at atmospheric pressure, provides its own source of power for circulation through a closed circuit and rate of flow of the cold gases may be controlled to regulate temperatures within storage compartments in cooling relation to the circuit.

It is, therefore, the principal object of my invention to utilize power, latent in a solid body of the refrigerating medium, for circulating cold gases through refrigerating apparatus upon reversion of the solid body to a gaseous state.

It is a further object of the invention to maintain substantially uniform differential temperatures in various compartments of refrigerating apparatus through control of circulation of the cold gases within a closed system of ducts leading from a primary refrigerant storage chamber.

For accomplishing the above named and other objects of my invention, I have provided apparatus particularly adapted for the practice of my improved method, the preferred form of which is illustrated in the accompanying drawings, wherein:

Fig. 1 is a perspective view of a refrigerating cabinet embodying improved details of structure.

Fig. 2 is a sectional perspective view of the cabinet, particularly illustrating circulation of the cold gases about storage compartments.

Fig. 3 is a central vertical section of the apparatus.

Fig. 4 is an enlarged vertical section of the mechanism for thermostatically controlling flow of the gases.

Fig. 5 is an enlarged horizontal section of an aspirator employed in the circulating system.

Fig. 6 is a fragmentary perspective view of a modified form of aspirator.

Referring more in detail to the drawings:

1 designates the cabinet as a whole, comprising outside, top, bottom, rear and side walls, 2, 3, 4, 5 and 6 respectively, composed of inner and outer metal sheets separated by insulating material 7 of cork or other suitable composition, the outer metal sheets of the side and bottom walls being extended over the front edges of the walls and turned back into the body of the cabinet throughout the greater portion of the height thereof and in spaced relation to the inner faces of said walls to form the side and bottom walls 8, 9 and 10 of a main cooling chamber and a gas

circulation duct between said compartment and the enclosing walls presently more particularly referred to.

The chamber, partially formed by said side and bottom walls, is completed by a back wall 11, spaced from the back of the cabinet to form an accumulation chamber in the circuit, and a top wall 12, the latter depressed throughout its central portion to form the bottom of a chamber 13 and cut away at its rear portion to provide a throat 14 for communicating the circulation space at the rear of the compartment with the chamber 13.

The inner walls of the main cooling chamber are spaced from the outer walls of the cabinet by suitable rails 15 and 16 at the front edges of the cabinet and the back of the chamber is spaced from the rear wall of the cabinet by blocks 17 converging upwardly at their facing edges to restrict flow of the gases into channel 18 leading to the throat 14.

The top wall of the main chamber is insulated by a body of cork, or the like, 19 interposed between the top wall 12 and a metal plate 20 attached to the side walls 8 and 9 in spaced relation to the top wall 12. The insulated top of the chamber, consisting of the wall 12, the plate 20 and the intervening insulating body 19 is inset from the front of the cabinet for a purpose presently disclosed, and extending forwardly from the upper portion of said wall to the front of the cabinet is a rib 21 also of insulating construction and preferably consisting of an extension of the top wall 12 about a contained body of insulating material and having a top flange overlying an upturned front flange on the plate 20, (Fig. 3).

The front edges of the side walls 5 and 6, the bottom wall 3 and the rib 21 are bevelled to seat a door 22 also of insulating construction and hinged at the vertical edge of one of the side walls. Supported on the top wall 12 and retained by lip 23 on the rib 21 is a metal plate 24 forming a cover for the chamber 13 and a support for the refrigerant containing and circulating elements now referred to.

Mounted edgewise on the plate 24 in spaced relation to form a central chamber in the upper portion of the cabinet and inset from the ends of the chamber 13, for a purpose presently mentioned, are bridge walls 25 and 26 of insulating construction terminating in spaced relation to the top wall 2 to form throats 27. Extending outwardly from said bridge walls and supported on rails 28 above the aspirators, presently described, are metal cooling chamber housings 29

spaced from the top wall 2, the side walls 5 and 6 and the plate 24 to form horizontal and vertical ducts 30 and 31 and underlying chambers 32.

I prefer to bevel the edges of the bridge wall 25 and the adjacent corners of the top wall 2 to form restricted inlets to the ducts 30.

Fixed to the facing sides of the bridge walls 25 in spaced relation to the plate 24 are rails 33 upon which is mounted a plate 34, preferably aluminium, constituting a supporting platform for a cake of solid carbon dioxide 35, the plate 34 separating the upper central chamber of the cabinet into a lower compartment 36 adapted for containing ice trays 37, and an upper compartment 38 adapted for containing the block of refrigerant.

The refrigerant containing compartment includes a throat 39 opening through the top of the cabinet and adapted for closure by a lid 40 having a bevelled edge 41 adapted for snug fit on a bevelled seat 42 formed in the top of the cabinet around the throat opening, the top 2 being preferably thickened to provide additional insulation at this point and conform to the chamber forming requirements.

The lid 40 may be locked in place by a cross bar 43 pivotally mounted on a stud 44 rotatable in an aperture 45 in the top member and provided with a knurled head 46 preferably located in a countersunk recess 47 in the upper face of the cover member, the cross bar 43 having bevelled ends adapted for engaging under lugs 48 on the wall of the throat 39 immediately beneath the bevelled seat, and the stud having a lug 49 adapted to seat in a notch 50 in the bar 43 to effect rotation of the bar to and from locking position under the lugs by rotation of the stud.

To retard evaporation of the solid refrigerant, I preferably cover the same with a felt or like pad 52.

Located in each of the chambers 32 below the side housings 29 is a circulation promoting and directing element 53 in the form of an aspirator comprising a block of non-heat-conductive material adapted to lie on the plate 24 and having a plurality of Venturi-throats 54 extending longitudinally therethrough, the inner end of each block being spaced from the adjacent bridge wall 25 by nipples 55 extending downwardly from the inner ends of the respective Venturi-throats into apertures 56 in the plate 34 to anchor the aspirator blocks, and provide communication between said chamber and the Venturi-throats. The outer ends of the Venturi-throats of the respective aspirator blocks communicate with ducts 57 formed between inner and outer walls of the lower portion of the cabinet and the upper ends of the blocks are extended to contact with the inner faces of the walls 5 and 6 to close communication between the ducts 31 and 57.

Extending into the inner end of each of the Venturi-throats is a nozzle 58 for discharging gases from the ducts 31 into and through the throats for circulation through the ducts, the space 59 between the inner and outer walls at the bottom of the cabinet, the space 60 between the inner and outer walls at the rear of the cabinet and thence into the throat 18 for return to the aspirator through the apertures 56 in the wall 24. The space 59 at the bottom of the cabinet is divided by a rail 61 to direct flow of gases to the space at the back of the cabinet.

The open front ends of the ice tray chamber and of the cooling chamber housings 29 may be closed by a door 62 separate from the main door

22 to provide selective access to the upper and lower cooling chambers, the upper door fitting against bevelled edges of a recess in the front wall of the cabinet and against the bevelled edge of the rail 21 to provide a close fit for the door.

Temperatures in the several cooling chambers are proportional to the rate of circulation of the cooling gases and dissipation of the gas from the cooling system, through a bleeding valve 63, preferably located in the back wall of the cabinet in communication with the circulation space 60 and of adjustable type to effect relief of the gases at any desired pressure.

Regulation of the temperature and maintenance of substantially uniform temperature may be effected through manually adjustable thermostatic control of a flow regulating valve in the circulatory system, preferably including a butterfly valve 64 in the throat channel 18 at the back of the cabinet connected through a rod 65 with a spiralled tube 66 attached to a pivot rod 67 mounted in the side walls of the channel 18 and having an extension 68 projected through a bearing 69 into the lower storage compartment of the cabinet. The tube 66, 68 is filled with a gas, such as carbon dioxide readily expansible or contractible in response to temperature changes to shift the valve in accordance with common practice.

The rod 65 is adjustable through a turn buckle 70 for initial setting of the valve and the valve is secondarily adjustable for selective regulation through a segmental rack 71 on the rod 67, by means of a worm 72 on a rod 73 that extends rotatably through the top of the lower storage compartment and is provided at its forward end with a knob 74 provided with graduated markings for coordination with a dial 75 on the front of said top member.

The extension 68 of the thermostat tube 66 is preferably supported from the underside of a shelf 76 in the upper portion of the main cooling chamber by clips 77 or the like.

In Fig. 6, I have illustrated a modified form of aspirator consisting of a single Venturi-throat 78 extending entirely across the aspirating member and a single nozzle 79 for discharging high pressure gas through the Venturi-throat.

Other changes in details of mechanical construction of the refrigerating apparatus may be made without departing from the spirit of the invention.

In practicing my method with apparatus of the character described, a block of dry ice is placed in the chamber at the top of the cabinet, preferably covered with felt pad and the chamber sealed by locking the cover member to its seat.

The block of solid carbon dioxide sublimating at a temperature at approximately 110° below zero, expands to approximately 700 times its solid cubic inch volume, thereby generating internal pressure tending to impel the cooled gases through the ducts about the upper cooling chambers to the aspirator nozzles and through the nozzles and Venturi-throats into the side ducts 57, through which it passes by gravity and its own impelling force to the space at the bottom of the cabinet and into the space 60 at the back of the cabinet immediately below the filler blocks 17, upwardly through the channel 18 and throat 14 into the chamber 13 and thence through the ports 56 into the Venturi-throats for recirculation; aspiration by the nozzles tending to draw the gases, made lighter by absorption of heat units during their circulation about the storage compartment, through the channel 18, the throat

14 and chamber 13 to mingle with the fresh gases emanating from the refrigerant chamber.

With the pressure valve 63 set to operate at a pressure of approximately five pounds, temperatures of approximately 40° and zero may be maintained respectively in the lower and upper cooling chambers and variation of temperatures in the chambers may be effected by regulation of the pressure relief valve, but such variation is preferably effected by regulation of the butterfly valve controlling rate of flow of the cooling gas.

The ice tray compartment 36 immediately beneath the refrigerant supporting platform is not affected materially by regulation of the circulating gases, as it is cooled directly by absorption from the refrigerant and contents of a tray in said compartment, being directly responsive to cooling action of the refrigerant, may be quickly frozen.

What I claim and desire to secure by Letters Patent is:

1. A refrigerator including separate refrigerant and refrigerating chambers, a closed circuit of ducts arranged for conducting gases from the refrigerant chamber in cooling relation to the refrigerating chamber, and an aspirator in the circuit for promoting recirculation of gases through the ducts.

2. A refrigerator having a closed receptacle for receiving solid carbon dioxide, an outer cabinet including rear and side walls, an inner cabinet spaced from said walls to form communicating rear and side conduits, ducts communicating said receptacle with the side conduits, aspirating elements in said ducts, an accumulating chamber in communication with said elements, a passage connecting the chamber and rear conduit, and a control valve in said passage.

3. A refrigerator having a closed receptacle for receiving solid carbon dioxide, an outer cabinet including rear and side walls, an inner cabinet spaced from said walls to form communicating rear and side conduits, ducts communicating said receptacle with the side conduits, aspirating elements in said ducts, an accumulating chamber in communication with said elements, an upwardly converging passageway connecting the chamber and rear conduit, a control valve in the passageway, and a relief valve for venting said conduits of excessive pressure.

4. A refrigerator having a closed receptacle for receiving solid carbon dioxide, cooling chambers adjacent opposite sides of the receptacle, an outer cabinet including side and rear walls, an inner cabinet forming a separate cooling chamber spaced from said walls to form communicating side and rear conduits, ducts leading from said receptacle around the first named chambers to the side conduits, aspirating elements in said ducts, an accumulating chamber in communication with the aspirating elements, a passage connecting said accumulating chamber with the rear conduit, a valve in the passage, and temperature responsive means for actuating the valve.

5. A refrigerator having a closed receptacle for receiving solid carbon dioxide, cooling chambers adjacent opposite sides of the receptacle, an outer cabinet including side and rear walls, an inner cabinet forming a separate cooling chamber spaced from said walls to form side and rear conduits, ducts leading from said receptacle around the first named chambers to the side conduits, aspirating elements in said ducts, an accumulating chamber in communication with the

aspirating elements, a passage connecting said accumulating chamber with the rear conduit, a valve in the passage, and thermostatic means, including a tube of gaseous carbon dioxide, for actuating the valve.

6. A refrigerator including inner and outer cabinets spaced to form a passageway for circulation of gas about the inner cabinet, means dividing the upper portion of said passageway into lateral primary sections and an intermediate return section, a receptacle for solid carbon dioxide in the upper portion of the cabinet communicating with the lateral sections of the passageway, and an accumulating chamber communicating with the return section and with the respective lateral sections of the passageway for recirculation of gases through the passageway.

7. A refrigerator including inner and outer cabinets spaced to form a passageway for circulation of gas about the inner cabinet, means dividing the upper portion of said passageway into lateral primary sections and an intermediate return section, a receptacle for solid carbon dioxide in the upper portion of the cabinet communicating with the lateral sections of the passageway, an accumulating chamber communicating with the return section and with the respective lateral sections of the passageway for recirculation of gas through the passageway, and pressure responsive means for venting gas from the return section of said passageway.

8. A refrigerator including inner and outer cabinets spaced to form a passageway for circulation of gas about the inner cabinet, means dividing the upper portion of said passageway into lateral primary sections and an intermediate return section, a receptacle for solid carbon dioxide in the upper portion of the cabinet communicating with the lateral sections of the passageway, an accumulating chamber communicating with the return section and with the respective lateral sections of the passageway for recirculation of gas through the passageway, pressure responsive means for venting gas from the return section of said passageway to maintain substantially uniform pressure in the system, a damper in the return section of said passageway, and means responsive to change in temperature within the inner cabinet for actuating the damper to regulate rate of flow of gas in the system.

9. A refrigerator including inner and outer cabinets spaced to form a passageway about the inner cabinet, means forming primary and return sections in the upper part of the passageway, a receptacle for solid carbon dioxide, ducts communicating said receptacle with the primary sections of said passageway, an accumulating chamber communicating with the return section of said passageway and with said ducts for recirculation of returned gas with fresh gas sublimated from the solid carbon dioxide, and pressure responsive means for venting said gas from the return section of said passageway.

10. A refrigerator including inner and outer cabinets spaced for circulation of gas therebetween, means in the upper portion of said space forming primary sections and an intermediate return section including a throat, a receptacle for solid carbon dioxide in the upper central portion of the refrigerator, ducts communicating said receptacle with the primary sections of the circulation space, and an accumulating chamber in communication with said throat and with said ducts for returning gas to the circulation space

for recirculation along with fresh gas sublimated from solid carbon dioxide in said receptacle.

11. A refrigerator including inner and outer cabinets spaced for circulation of gas therebetween, means in the upper portion of said space forming primary sections and an intermediate return section including a throat, a receptacle for solid carbon dioxide in the upper central portion of the refrigerator, ducts communicating said

receptacle with the primary sections of the circulation space, an accumulating chamber in communication with said throat and with said ducts for returning gas to the circulation space for recirculation along with fresh gas sublimated from solid carbon dioxide in said receptacle, and aspirators in said ducts for promoting recirculation of returned gases.

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