Feb. 20, 1940. A. A. MICHALSKE 2,190,796

REFRIGERATING PROCESS AND APPARATUS

Filed Sept. 26, 1938 2 Sheets-Sheet 1

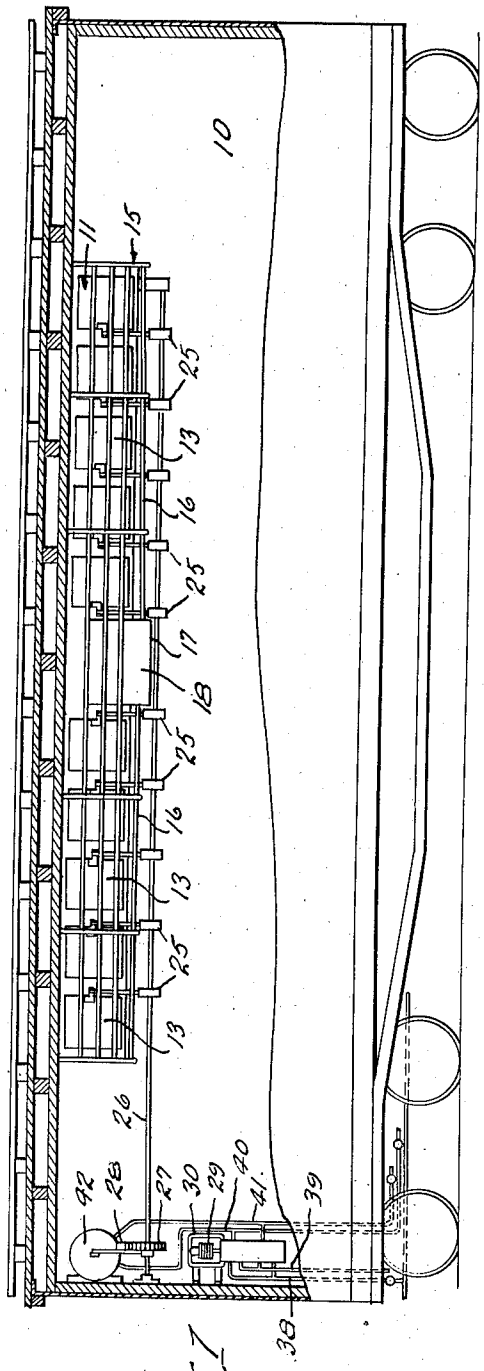


Fig. 1

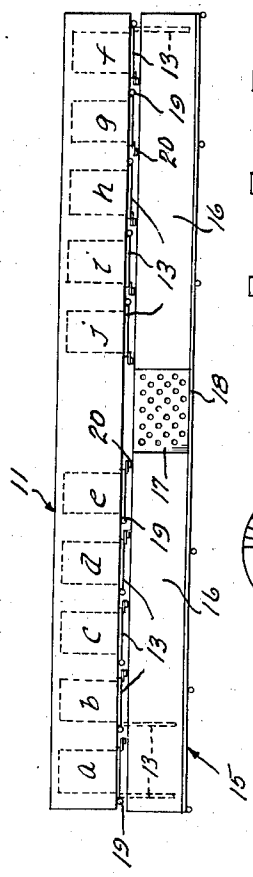


Fig. 3

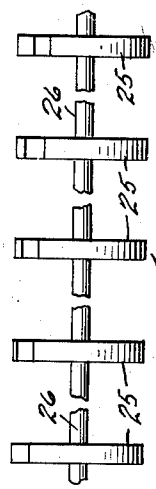


Fig. 8

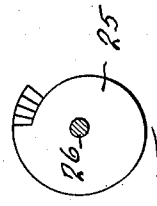


Fig. 9

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REFRIGERATING PROCESS AND APPARATUS

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Fig. 4

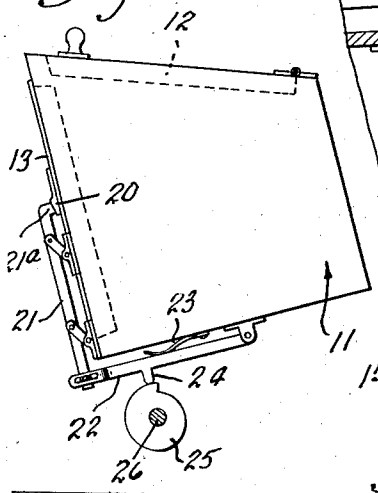


Fig. 2

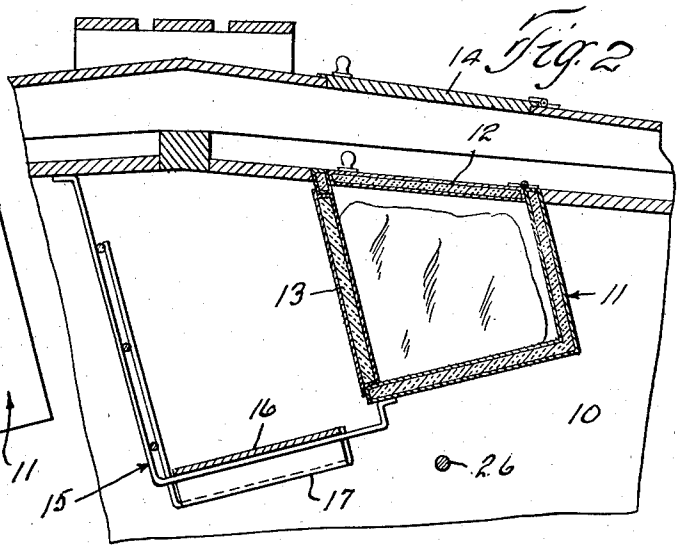
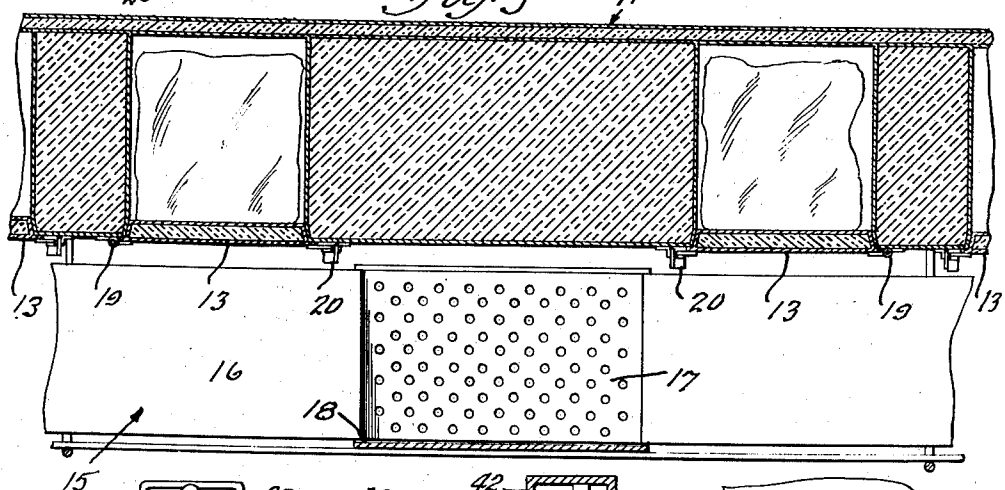


Fig. 5



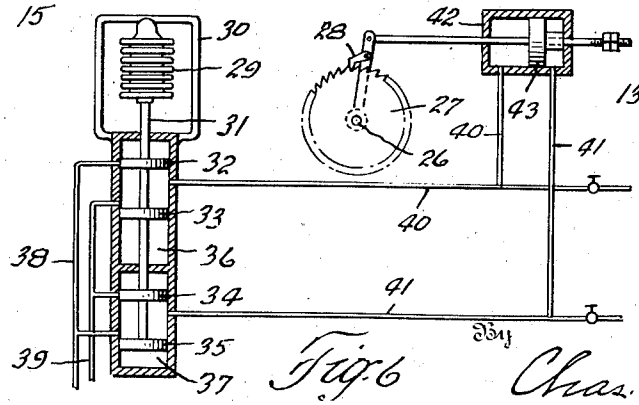


Fig. 6

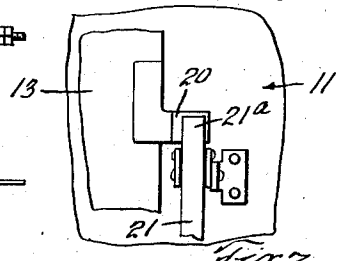


Fig. 7

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REFRIGERATING PROCESS AND APPARATUS

Arthur A. Michalske, Cleveland, Ohio

Application September 26, 1938, Serial No. 231,614

8 Claims. (Cl. 62—91.5)

This invention relates generally to a process and apparatus for maintaining the temperature in a refrigerating chamber within predetermined limits, according to requirements thereof, thru the medium of a solid refrigerant, for relatively long periods of time.

The principal object of the invention is the provision of a process and apparatus for automatically subjecting a refrigerating chamber to the cooling action of a solid refrigerant in such a manner as to maintain the temperature in the refrigerating chamber within predetermined limits for definite periods of time.

Another object of the invention is the provision of a process and apparatus of this character wherein a solid refrigerant is automatically supplied to a refrigerating chamber in predetermined quantities as required by the temperature in the refrigerating chamber, to maintain it within prescribed limits.

Another object of the invention is the provision of a process and apparatus for maintaining the temperature in a refrigerator car, truck or the like, within prescribed limits, thru the medium of a solid refrigerant, throughout the duration of a trip which will eliminate stopping to replenish the refrigerant when excessive temperatures or delays are encountered; or when the trip is of such an extent that it would be impossible to plan sufficient refrigerant therein to last throughout the trip, without at first producing an excessively low temperature within the car, truck, or the like.

Another object of the invention is the provision of a process and apparatus of this character which are particularly adapted for utilizing "dry ice" (solidified CO_2) for a refrigerating medium in such a manner as to maintain the temperature in a cooling chamber within predetermined limits.

Other and more limited objects of the invention will be in part obvious and in part pointed out in connection with the accompanying drawings wherein Fig. 1 is a semi-diagrammatic representation of a refrigerator car, a part thereof being in section and indicating a structure according to the invention any place in such refrigerator car; Fig. 2 is a fragmentary transverse section taken transversely of the upper central portion of the structure shown in Fig. 1; Fig. 3 is a planned view of the refrigerant containers and the refrigerant rack indicated in the upper central portion of Fig. 1; Fig. 4 is an elevational view looking at Fig. 3 from right to left; Fig. 5 is a fragmentary planned section taken thru the refrigerant compartment and rack shown in Fig. 2; Fig. 6 is a diagram showing the temperature responsive control mechanism for operating the closures of the refrigerant containers or receptacles; Fig. 7 is a detailed view of one of the latch mechanisms; Fig. 8 is a detail of the latch operating cam shaft; and Fig. 9 is an end view looking from left to right in Fig. 8.

The novel process consists essentially in cooling a compartment which is to be kept within predetermined temperature limits by the use of an amount of refrigerant such as will reduce the temperature to or near but not below the low limit, at the same time bringing under automatic control a further quantity of refrigerant, in quantity greater than could be safely used initially, and maintaining such further supply available and automatically effective to hold the temperature below the upper limit. This process of cooling is especially useful in cases where the initial supply of refrigerant to the compartment cannot be made sufficient to hold the temperature low enough for the necessary time interval without being initially too low. An example is in the transportation of certain perishable foodstuffs which must not be frozen.

Referring now to the accompanying drawings, the numeral 10 indicates generally a refrigerator railroad car, which might equally well take the form of a truck or a storehouse. The invention will be described with especial reference to refrigeration during transportation but it is to be understood that it may be applied to analogous situations. Attached to the top of the refrigerator car 10 in any suitable manner is a refrigerant receptacle assembly 11 made up of a plurality of heat insulated compartments, each of which is provided with a top closure 12 for the introduction of solid refrigerant and a delivery closure 13 thru which such solid refrigerant is to be delivered automatically responsive to predetermined temperature conditions within the interior of the car 10. The closure 14 is provided for access to the closure 12. It will be noted that the bottom wall of the compartments in the assembly 11 extends downwardly at an angle sufficient to discharge the solid refrigerant therefrom upon the release of the latch which holds each closure 13 in closed position.

In front of the series of closures 13 is a rack indicated generally by the reference numeral 15, and which may be made up, as indicated, of bars and sheet metal but which may be of a similar construction, not however of such construction as to insulate the solid refrigerant from the interior of the car or in any way to prevent the refrigerant supported thereby from exerting its cool-

ing action. Preferably the plates 16 forming the bottom of the rack 15 slope downwardly toward a central perforated section 17, whereby when each body of refrigerant is released from its compartment, it will gravitate to the perforated section 17. Extending upwardly and outwardly from the bottom walls 16 is a vertically disposed wall 18 which the bodies of solid refrigerant may contact. It is contemplated that at the beginning of a trip, the rack 15 may be filled or partly filled with bodies of solid refrigerant sufficient to reduce the temperature of the car as low as may be practical but not below a safe limit for the material being transported and that the insulated compartments will be supplied with one or more bodies of solid refrigerant, sometimes an amount which would reduce the temperature in the car below a safe point if it were not initially insulated from the space to be cooled. When the temperature within the car rises above a predetermined limit, temperature responsive control mechanism will operate to open the closures 13, preferably one at a time, thereby maintaining the temperature within the car below the upper temperature limit which is considered unsafe or undesirable.

Each of the closures 13 is hinged as indicated at 19 and provided at its opposite edge with a latch mechanism. When the latch mechanism is released, the closure 13 will be opened by the weight of the body of solid refrigerant resting thereagainst, whereby such refrigerant will slide on to the rack 15. The latch mechanism may consist of a strike 20 projecting beyond the edge of the closure 13 as best seen in Fig. 7. Secured to a fixed portion of the container assembly 11 is a parallelogram linkage 21, a portion 21a of which is adapted to engage the strike 20 whereby to hold the closure 13 in closed position. Pivoted to the under side of the assembly 11 is a cam follower 22 connected by pin and slot connection to the element 21 and urged downwardly by a leaf spring 23. A projection 24 on cam follower 22 engages, in each case, one of a series of cams 25 carried by cam shaft 26. The various cams 25 are of similar profile but angularly spaced around the cam shaft 26 as best seen in Fig. 9. It will be obvious that if the cam shaft is rotated to such a position as to release one of the closures 13, cooling will be produced due to the release of refrigerant from one compartment and that such cooling will operate a thermally sensitive element. The resulting motion of the thermally sensitive element may be utilized to cause a step by step rotation of the cam shaft 26.

This effect may be accomplished by a pawl and ratchet mechanism, the ratchet 27 being fixed to the cam shaft 26 and operated by a pawl 28. Inasmuch as the thermally sensitive element could not practically be made to operate the pawl directly, I prefer to operate the pawl by means of a fluid pressure device controlled by valves actuated by the thermally sensitive element. Accordingly, as best seen in Fig. 6, I provide a Bellows type of thermally sensitive device, indicated at 29, the same being secured at one end to a mounting element 30, and carrying a valve operating rod 31. Secured to the rod 31 are valve elements 32, 33, 34, and 35, the first two of which operate in a cylinder 36 and the last two of which operate in a cylinder 37. Compressed air or the like is supplied thru a conduit 38 and is delivered to conduits 40 and 41 in accordance with the setting of the valve elements 32 to 35. The valve mechanism is shown in Fig. 6 in the condition it assumes just when a body of solid refrigerant is to be discharged, that is with the Bellows 29 expanded as a result of a temperature condition requiring cooling. In this position, compressed air flows from the supply line 38 thru the cylinder 37 and conduit 41 into the power cylinder 42, thereby actuating the piston 43 to the left, advancing the ratchet 27 to operate one of the cams 25. The piston 43 pushes air thru the conduit 40 and cylinder 36 to a discharge line 39. If now the Bellows 29 contracts, as it will do responsive to discharge of a body of refrigerant to the rack 15, the pressure line 38 will be opened thru the cylinder 36 to the conduit 40 and power cylinder 42 whereupon the piston 43 will move to the position indicated in Fig. 6, air being pushed thru the conduit 41 and cylinder 37 to the exhaust line 39. The cams 25 are so arranged on the cam shaft 26 that the doors 13 will be opened successively in the following order, *a, b, c, d, e, f, g, h, i, j*, as is indicated in Fig. 3. By this arrangement none of the doors 13 will interfere with any of the refrigerant as it travels along the rack 15 to the perforated support 17.

While I have described the application of my invention in detail with respect to an illustrative embodiment thereof, being the present preferred mode of realizing the invention, I wish it understood that I am not limited to the details of the embodiments illustrated but only in accordance with the appended claims.

Having thus described my invention, what I claim is:

1. In an apparatus of the character described, the combination of a refrigerating chamber, a plurality of insulated compartments for solid refrigerant, each having a door opening into said chamber, and means responsive to the temperature in said chamber for successively opening the doors of said compartments and discharging the refrigerant therein into said chamber.

2. The combination of a refrigerating chamber, a storage compartment for solid refrigerant adjacent said chamber, a door between said chamber and said compartment, a latching mechanism for holding said door closed, and means, responsive to a predetermined temperature in said chamber, for releasing said latching mechanism to establish communication between said chamber and said compartment, and discharging the refrigerant therein into said chamber.

3. The combination of a refrigerating chamber, a receptacle therein adapted to contain an initial supply of solid refrigerant, a plurality of storage compartments, each containing a reserve supply of solid refrigerant, means responsive to temperature changes in said chamber for successively releasing the refrigerant in said compartments, and means for conveying the released refrigerant from said compartments to said receptacle.

4. The combination of a refrigerating chamber, a receptacle therein adapted to contain an initial supply of solid refrigerant, a plurality of insulated storage compartments, each adapted to contain a reserve supply of solid refrigerant, and means responsive to predetermined temperature changes in said refrigerating chamber for successively transferring the refrigerant in said storage compartments to said receptacle.

5. A refrigerating process comprising, precooling a refrigerating chamber to the desired

temperature by placing an initial supply of solid refrigerant therein, placing a reserve supply of solid refrigerant in a storage compartment adjacent said chamber, and then automatically transferring the solid refrigerant from said storage compartment to said chamber when the temperature in said chamber reaches a predetermined point.

6. A refrigerating process comprising, precooling a refrigerating chamber to the desired temperature, placing a solid refrigerant in each of a plurality of separate compartments, subjecting said chamber to the refrigerating action of the solid refrigerant in one of said compartments as required by the temperature in said chamber to maintain the temperature therein within predetermined limits, and then subjecting said chamber in a like manner in succession to the refrigerating action of the solid refrigerant in the rest of said compartments.

7. Process for maintaining the temperature of the cooling compartment of a traveling refrigerating device between predetermined upper and lower limits during a trip, comprising initially supplying said device with a quantity of solid refrigerant more than sufficient to reduce the temperature in said compartment to the predetermined low limit, initially thermally separating from said compartment a portion of said refrigerant, at least equal to the excess above the amount required to reduce the temperature of said compartment to the said low limit, and, in the course of the trip, causing said portion to be introduced into said compartment, automatically, responsive to temperature conditions within said compartment in increments, to the extent necessary to maintain the temperature of said compartment within said predetermined temperature limits.

8. Process for maintaining the temperature of the cooling compartment of a traveling refrigerating device between predetermined upper and lower limits during a trip, comprising initially supplying said device with a quantity of solid refrigerant more than sufficient to reduce the temperature in said compartment to the predetermined low limit, initially thermally separating from said compartment a portion of said refrigerant, at least equal to the excess above the amount required to reduce the temperature of said compartment to the said low limit, and, in the course of the trip, causing said portion to be brought into thermal communication with said compartment, automatically, responsive to temperature conditions within said compartment, in increments, to the extent necessary to maintain the temperature of said compartment within said predetermined temperature limits.

ARTHUR A. MICHALSKE.