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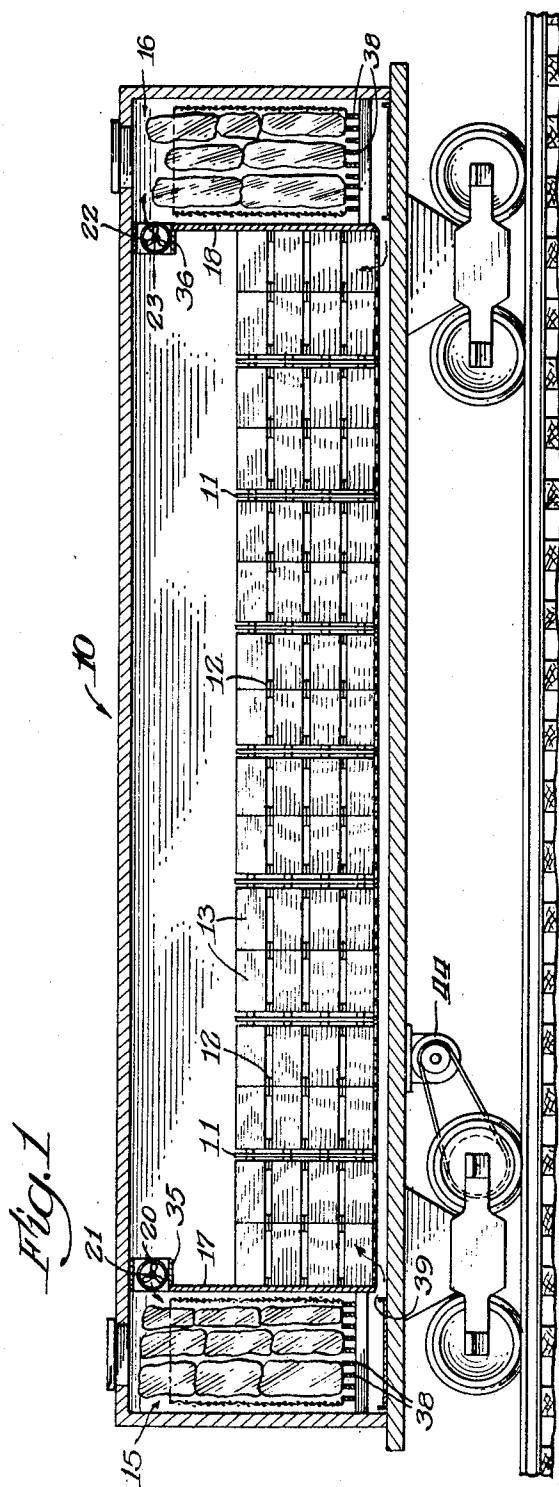
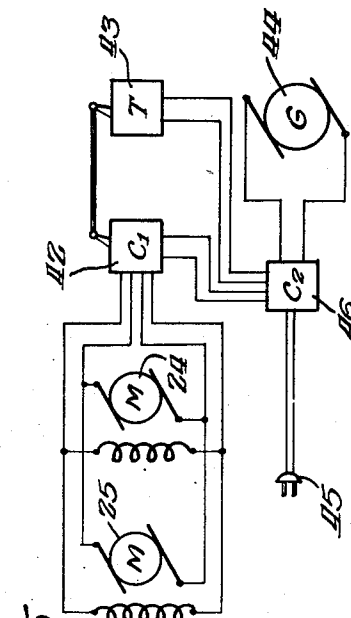
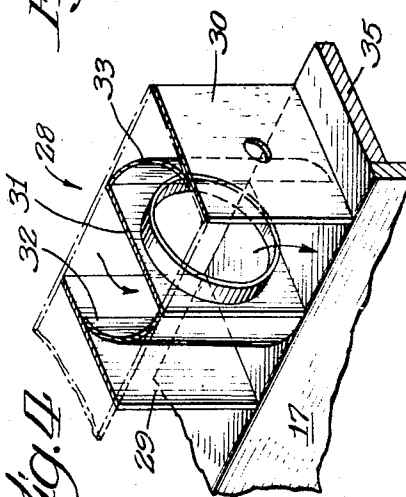
F. J. REILLY

2,477,823

AIR CONDITIONING SYSTEM

Filed Aug. 14, 1947

2 Sheets-Sheet 1



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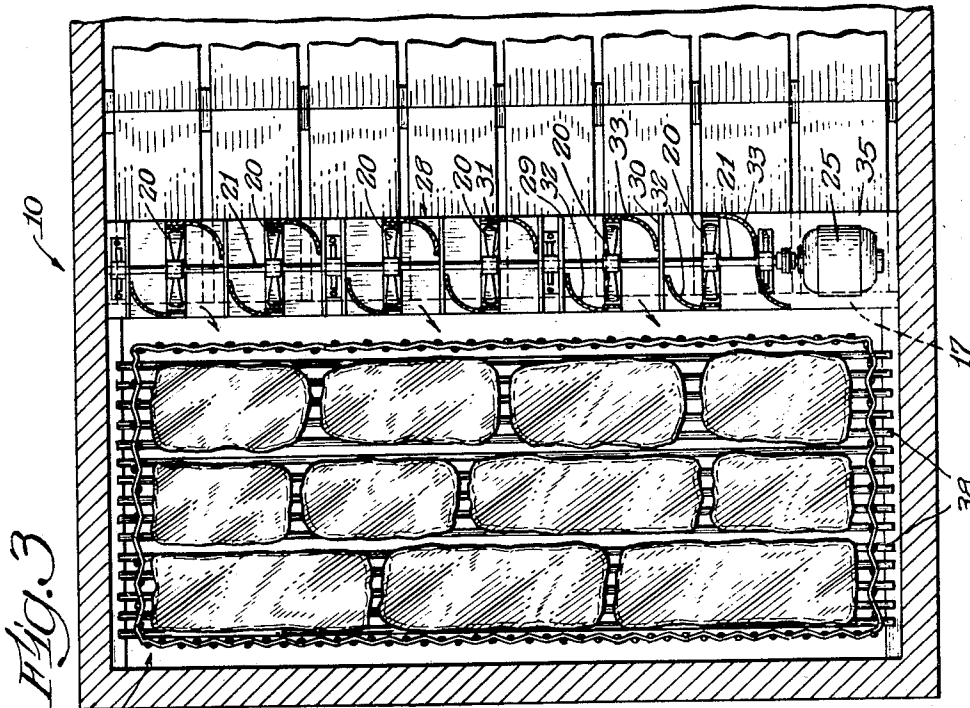
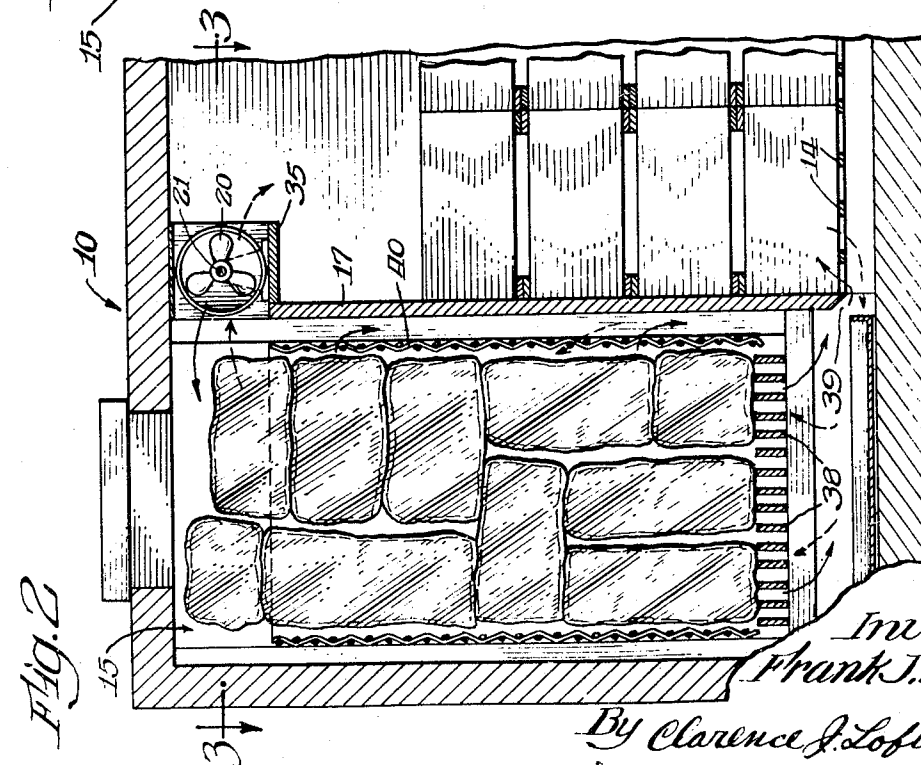
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UNITED STATES PATENT OFFICE

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AIR CONDITIONING SYSTEM

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Application August 14, 1947, Serial No. 768,589

5 Claims. (Cl. 62-24)

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This invention relates to air circulating systems and specifically to a novel refrigerating system having particular utility as employed in railway refrigerator cars.

It has heretofore been found that edible commodities may be preserved in fresh condition during the transportation period—often very long—between the time of loading at the place of production and the time of unloading at the place of distribution or consumption, by maintaining them in a cooling medium at a temperature on the order of 40° F. Air circulating systems including means for cooling the air are generally used for performing this refrigerating operation.

Serious long unsolved problems peculiar to the transportation industry arise in employing air circulating systems in refrigerator cars and the like. First, the air is most advantageously forced through the lading from bottom to top, for example. The lading may have a height in excess of six feet. The air must flow through the load for a considerable distance before it emerges. The result is that, while the lower portions of the lading in proximity to the points of entry of the air are cooled to a temperature near that of the air, the upper portions of the lading near the points of departure of the air are cooled but little if at all. In some cases, even after thirty minutes of operation the bottom portions of the load may have a temperature on the order of 40° F. and the top portions of the load may have a temperature on the order of 75° F. If the temperature of the cooling air be decreased in an attempt to cool those top portions down to the desired temperature, the cost of ice would be increased and the temperature level of the lower lading portions would become so low as to destroy such commodities as citrous fruits, for example. It is not practicable, in fact, to lower the temperature of the cooling air to that extent. The freezing point of practically all produce so shipped is on the order of 30° F. True it is that, after a time the temperature will equalize, but equilibrium may occur at a temperature higher than is desired for proper transportation of the commodity, or demand an excessive amount of ice. At best, much time will be consumed in equalizing.

This dilemma poses a problem for which the shipping, railway and refrigerator car industries demand a solution. Certain other requirements of these industries narrow the field in which the solution must be sought. It is desirable not to depart radically from standard railway loading practices. Standard refrigerator cars should be used and structural elements tending to obstruct

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loading operations and to consume revenue-producing space are to be avoided, wherever possible.

Second, air forced in one general direction through a bulky lading, although initially finding its way therethrough in random paths, tends ultimately to settle in fairly defined channels. Only a part of the total surface area of the various items of the lading is then exposed to the influence of the cooling air. The remaining surface area is not fully exploited for heat-transfer purposes.

Third, dispatch and promptness are at a premium in transportation and the channels of commerce, so that it is highly desirable to produce an even temperature throughout the lading as soon as possible and to maintain that temperature.

Fourth, ice, the usual cooling agent, is not only per se an expense item, but is also a non-revenue load, wherefore it is also desirable that ice-consumption be reduced to a minimum.

An important object of the invention is to provide a refrigerating system which satisfies these peculiar requirements and has such structure and operation that the whole lading is rapidly cooled to a substantially uniform temperature and maintained thereat, without overcooling or undercooling any appreciable part thereof.

Another important object of the invention is to provide a refrigeration system wherein the maximum surface area of the lading is exploited for heat-transfer purposes and the pattern of air distribution is periodically changed.

A further primary object of the invention is to provide a heat-transfer system having such structure and operation that the object is placed at a desired uniform temperature in a relatively short time.

It is also a basic object of the invention to provide a reversible air-circulating cooling system which is characterized by less ice consumption than conventional cooling systems.

A further object of the invention is to provide a periodically reversible air circulating system and controls therefor.

The invention has for another object the providing of an air-circulating cooling system having such structure and operation that it may readily be installed in standard refrigerator cars.

Still another object of the invention is to provide such a system without introducing ducts of a character which unduly consume revenue-producing space, require major car-structure modifications or obstruct normal loading operations.

Other and further objects and advantages of

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the invention will become apparent from the following description of the following drawings, in which there is shown an illustrative embodiment of my invention in a preferred form.

In the drawings:

Fig. 1 is a side elevational sectional view showing an air-circulating cooling system in accordance with my invention installed in a standard refrigerator car;

Fig. 2 is an enlarged fragmentary view of portions of Fig. 1, showing one of the circulating fans and one of the ice bunkers;

Fig. 3 is a sectional view taken on line 3—3 of Fig. 2;

Fig. 4 is a perspective view of one of the air deflectors; and

Fig. 5 is a schematic diagram of an electrical circuit suitable for use in controlling the operation of the system.

My invention is adapted to be employed in heat-transfer systems generally, but it is particularly advantageous in satisfying the particular requirements and answering the long-standing needs of railway refrigeration, so that it is illustrated as embodied in a standard railway refrigerator car generally indicated by the numeral 10. The construction of such a car per se is well-known to the art so that further description thereof is not necessary or desirable herein. The lading is disposed in stacked rows. Suitable spacers 11, extending generally vertically, and 12, extending generally horizontally, are placed between the various crates 13 or items of the load in order to provide a multiplicity of vertical and horizontal channels for the ready passage of air, whereby the lading is effectively honeycombed. The lading is placed on a floor rack or grating comprising a plurality of spaced members 14, extending transversely of the car throughout the length of its loading area. Rearwardly and forwardly of the loading area are located ice bunkers 15 and 16, each defined by a bulkhead 17 and 18, respectively, and a car end wall.

One serious problem solved by the invention may be posed at this point. Cooling air at 35° F., say, flowing in a generally upward direction and flowing through the spaces between members 14 will, after a certain time following the beginning of circulation, cool the lower portions of the lading to a temperature of 40° F., say, but will leave the upper portions at a temperature of 75° F., say. Even though heat conduction within the lading tends to equalize those temperatures the upper portions, will always be at a considerably higher temperature than the lower portions of the lading. If the temperature of the cooling air be lowered to 20° F., say, not only would the cost of ice be prohibitive but the lower lading portions would then become so cool as to destroy certain edibles. In the absence of some remedial procedure, however, the upper portions of the lading are not sufficiently cooled to be preserved in transit.

In solving this problem, I provide the circulating system now described in detail. At one end of the car a plurality of reversible fans 20 are mounted for rotation on a common shaft 21, extending transversely of the car and powered by a driving motor 25. Fans 22, shaft 23 and motor 24 are similarly provided at the other end of the car.

Each fan is associated with a deflector 28, preferably made of sheet metal, consisting of end members 29, 30, an apertured partition member 31, within which the fan rotates, and arcuate baffles 32 and 33, one on each side of the partition.

The deflectors are aligned and disposed between

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shelves 35, 36, extending from bulkheads 17, 18, respectively, and the top of the car.

During one phase of operation cooling air flows from the ice, between spaced members 38 supporting the ice, openings 39 between the bulkheads and the car floor, between the members 14 under the lading, the air passages within the lading, to baffles 32, then through the ports in partitions 31 to baffles 33, finally through the ice-containing passageway defined by corrugated sheeting 40.

The fans in the rear and front of the car preferably turn in opposite directions. When the fans are reversed, the direction of flow of the cooling air reverses, in accordance with another phase of operation.

In order periodically to reverse the fans, field circuits of motors 24 and 25 are coupled to a controller 42, actuated periodically by a suitable electrical timing device 43 to effect periodic reversal of field current. The motors, controller and timer are energized by an axle-driven generator 44 when the car is running and by a suitable source of current (not shown), into which plug 45 is inserted when the car is standing still. A suitable controller 46 provides for selective operation from the last-mentioned source or from the generator, as desired. A timing interval of thirty minutes is preferred. That is, each phase of operation preferably consumes thirty minutes.

Many important results are achieved by this construction. These will be apparent from a description of a few typical phases of operation.

During a representative first phase of operation, cooling air flows generally vertically through the lading, reducing its lower portions to a temperature of, say, 60° F. and its upper portions to a temperature of, say, 70° F. At the end of the phase two phenomena occur. First, equalizing influences continue to play, whereby the temperatures of those two portions slowly tend to become uniform. In other words, conduction within the lading tends to produce uniform heat distribution. I fully exploit those influences but do not rely on them alone. Second, at the beginning of the second phase, the direction of cooling air flow is reversed by reversing the impeller fans. During the second phase the upper portions of the lading are reduced to a temperature of, say 60° F. and the lower portions are maintained at a temperature of 60°. A part of this reduction of the temperature of the upper portions is effected by the temperature-equalizing phenomenon.

At the beginning of the third phase, the direction of air flow is again reversed, and during that phase the temperature of the lower portion is reduced to, say, 50° F. and the temperature of the upper portion is maintained at, say, 60° F. Again, the equalizing phenomenon and the cooling air cooperate to make uniform the temperature throughout the lading.

During the fourth phase, the upper lading temperature is reduced to, say 50° F., while the lower lading temperature is maintained at 50° F. At the end of the fifth and sixth phases the temperature of the whole lading is uniformly reduced to 40°.

The temperatures mentioned above are illustrative only and are postulated in order to demonstrate the operating principles of the invention. It is immaterial whether the air passes generally upwardly or downwardly through the load during the first cycle. Further, six phases are more

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than the usual number required to obtain the desired uniform cooling of the lading.

By reason of the periodic reversal of air flow and complete exploitation of the equalizing phenomenon the invention makes practicable the rapid production of a substantially uniform temperature throughout the load. Further, the air first strikes the bottom of the lading during one phase of each cycle and the top of the lading during the alternate phases. It flows through slightly different random channels and in accordance with different air distribution patterns during those phases. The result is that a greater total surface area of the lading is exposed to the cooling air than would have been exposed had the cooling air circulation not been periodically reversed.

I have found that best results are obtained by reversing the air circulation every 30 minutes. This timing permits best use to be made of the equalizing phenomenon in practical operation. I have found that full advantages of the equalizing phenomenon is thus taken.

It should be noted that, were the circulation not reversed, the cooling air would always leave the lading at a relatively high temperature and would thereafter touch the ice at a greater temperature differential, rapidly melting the ice. In accordance with the invention, however, the circulation is periodically reversed, so that the average differential between the ice temperature and the temperature at which the air touches the ice is radically decreased, whereby the ice is not so rapidly consumed but average temperatures lowered equally. The result is a significant saving in ice consumption.

By utilizing a maximum contact area between air and lading, fully exploiting the equalizing phenomenon, and minimizing the last-mentioned differential, my system rapidly reduces the lading to a substantially uniform cool temperature and maintains it thereat, with a minimum ice consumption. Furthermore, the rate of cooling is dependent upon the temperature difference between the incoming air and the load which the incoming air strikes. By reversing the direction of air flow the warmer portion of the load is periodically subjected to the cooler air flow.

In cooling the products in a room or car with a cooling unit operating to discharge the air in only one direction, it would be desirable to turn or rearrange the packages to be cooled in order to present to the stream unexposed surfaces and reduce the cooling time, but that is wholly impracticable. However, the problem is solved with my present invention by merely reversing the direction of the air flow.

It will further be seen that with my invention the problem is solved without pre-empting any valuable lading space of the car and then the car, therefore, can be loaded continuously from bunker wall to bunker wall without leaving space or chamber opposite the side door of the car as the coolers are arranged at the upper end of the bunker wall near the roof of the car above the usual loading space.

While for the purpose of illustrating and de-

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scribing the present invention, a certain embodiment has been schematically shown and a particular application has been described, it is to be understood that the invention is not to be limited thereby, since such variations and applications are contemplated as may be commensurate with the spirit and scope of the invention set forth in the following claims.

Having thus described my invention, I claim:

1. In a refrigerator car of the type adapted to contain a lading so arranged as to define a plurality of criss-cross air passages, said car being constructed with a cooling-agent-chamber having air passageways at its top and bottom, at least one motor-powered reversible impeller positioned near the top of the car above the loading space so disposed and arranged as continuously to circulate cooling air from said chamber and through said lading, and a controller for periodically reversing said impeller and said flow of said air, whereby to cool the upper and lower portions of said lading to a substantially uniform temperature.

2. The method of cooling a load within a refrigerator car to a predetermined substantially uniform temperature which comprises the steps of loading the car with a lading of perishable products to provide a multiplicity of air channels, cooling air to a temperature substantially less than that of the lading, driving the air in one direction through said lading for a period on the order of thirty minutes to cool exposed surfaces thereof, and then driving the air in another direction through said lading for a period on the order of thirty minutes to cool other exposed surfaces thereof while permitting heat equalization to occur, whereby said heat equalization and the bidirectional air circulation cooperate to reduce said lading to a uniform low temperature.

3. The combination in accordance with claim 1 wherein the impeller comprises a plurality of spaced fans mounted for rotation on a common shaft.

4. The combination in accordance with claim 1 wherein the impeller comprises a plurality of fans mounted on a common shaft extending transversely of the car and across the air passageway at the top of the cooling agent chamber.

5. The combination in accordance with claim 1 wherein the impeller comprises a plurality of axial flow fans spaced apart from each other on a common shaft extending transversely of the car, with deflectors between said fans to change the direction of movement of the air as it approaches and leaves the fans.

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