Aug. 31, 1948. J. I. MORRISON 2,448,453

LIQUID COOLING SYSTEM

Filed Sept. 11, 1944

Fig. 1.

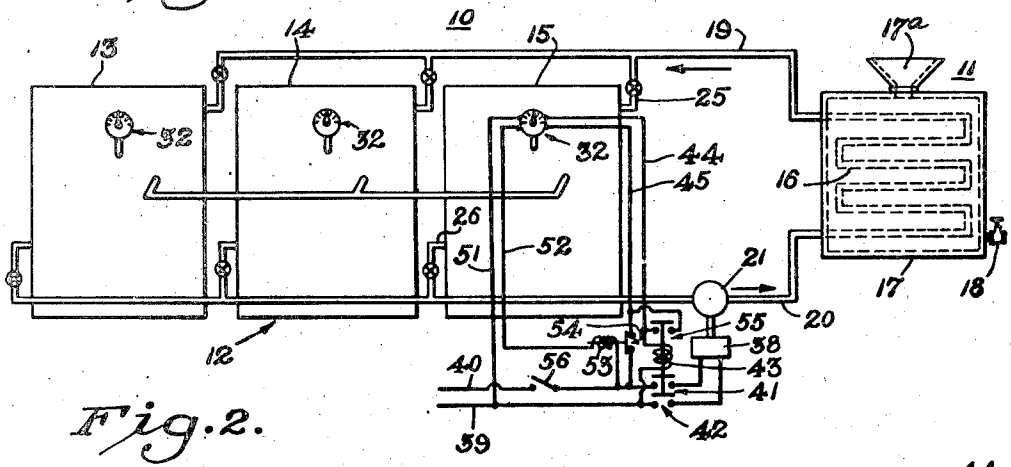


Fig. 2.

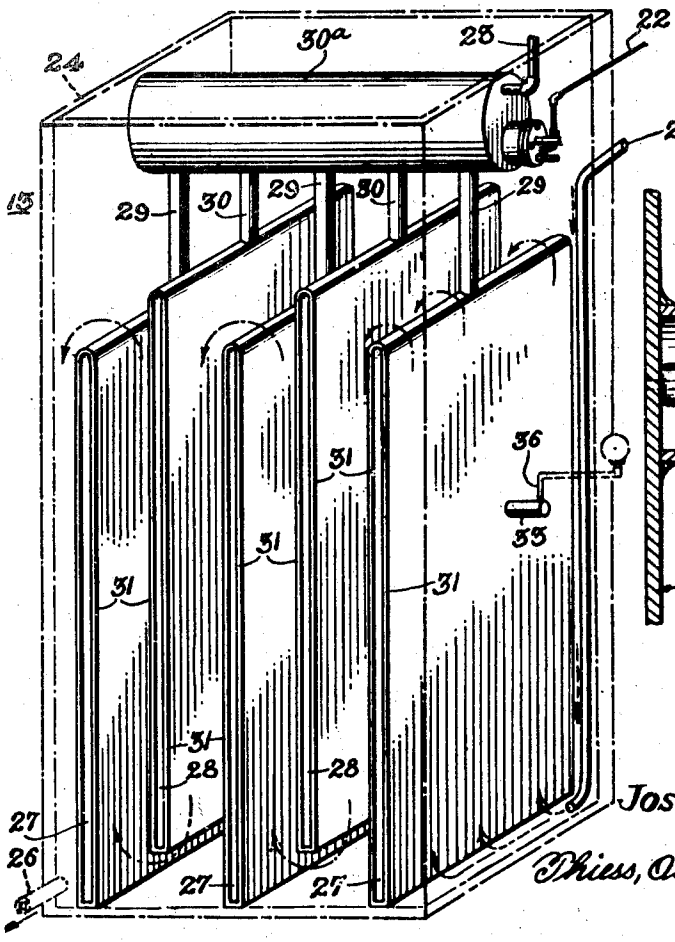
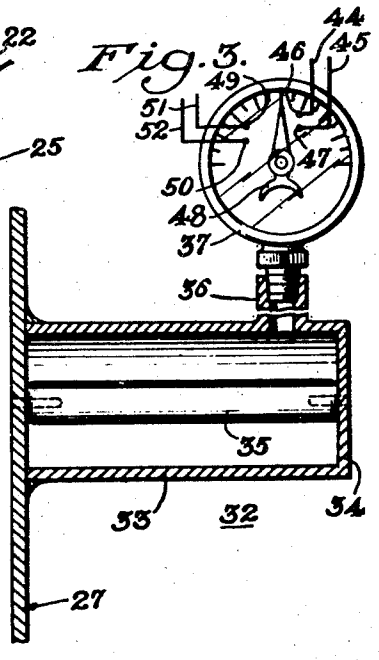


Fig. 3.



Inventor
Joseph I. Morrison
By
Kiess, Olson & Mecklenburger
Attorneys.

Patented Aug. 31, 1948

2,448,453

UNITED STATES PATENT OFFICE

2,448,453

LIQUID COOLING SYSTEM

Joseph I. Morrison, Lincolnwood, Ill.

Application September 11, 1944, Serial No. 553,495

6 Claims. (Cl. 62—141)

1

This invention relates to cooling systems, more particularly to periodically on and off cooling systems wherein the cooling fluid is water circulating over ice formed by freezing the water on suitable freezing surfaces and it is an object of the invention to provide improved means of this character.

Cooling systems of the general character indicated above have heretofore been provided for use in the dairy industry in milk receiving stations for cooling milk brought in from dairies or other milk producers. After the milk has been brought to the receiving or collecting station, it must be cooled from its original temperature to approximately 40° F., and in order not to destroy the vitamins contained in the milk, as well as other valuable food ingredients, the cooling process must be carried out at a moderate rate in a careful and well-regulated manner, as is well understood. Since the amounts of milk or other perishable food products may vary over rather wide limits, it is necessary that sufficient cooling capacity be available to take care of any increased amount of material to be cooled without varying the rate of cooling in order to prevent deterioration. It is, therefore, imperative that such cooling systems be flexible so that sufficient refrigeration of the type required may be available when needed without increasing the idle refrigeration capacity unduly when the refrigeration needed is small. Accordingly, it is a further object of the invention to provide an improved cooling system of the character indicated that is compact, flexible and highly efficient.

It is a further object of the invention to provide improved means for controlling the operation of a cooling system of the on and off type.

It is a further object of the invention to provide means responsive to amount of refrigeration available for controlling the operation of a cooling system of the on and off type.

A further object is to provide a highly efficient complete unit which can be shipped and erected prefabricated.

A further object is to provide improved apparatus for furnishing ice water for the cooling of milk products, ingredient water for food processing, or any other requirement where cold water is demanded.

While the invention has particular application to milk coolers, it will be understood by those skilled in the art that modifications may be made to adapt the invention to any cooling system where close and careful control of the cooling must be exercised.

2

In carrying out the invention in one form, an on and off cooling system is provided including a cooler and a refrigerator with cooling coils in the cooler connected to the refrigerator which comprises a series of heat exchangers adapted to receive a refrigerant for freezing ice on relatively wide surfaces of the heat exchangers. The cooling coils and the refrigerator are substantially filled with water and means are provided for circulating the water when desired over the wide surfaces thereon so that ice will be formed and accumulated on the surfaces while the water is not circulating to provide a reserve of ice which may be drawn upon and melted to effect cooling of the cooler when the water is circulated.

The fact that a reserve of B. t. u. can be stored in the ice allows a relatively smaller capacity refrigerating machine running longer number of hours to produce the same cooling effect as a larger machine running shorter number of hours.

For a more complete understanding of the invention, reference should now be had to the drawings, in which

Figure 1 is a schematic view of a cooling system embodying the invention;

Fig. 2 is a perspective view of one refrigerating unit of the cooling system showing operative elements, the tank being shown in phantom lines; and

Fig. 3 is an enlarged sectional view of a gauge shown in Fig. 1.

Referring to Fig. 1 of the drawings, the invention is shown embodied in a cooling system 10 comprising a cooler 11 and a refrigerator 12 including the refrigeration units 13, 14 and 15. Cooling coils 16 are arranged in the tank 17 of the cooler 11 which is provided with an inlet 17a and an outlet 18, the coils 16 being connected to the refrigeration units 13, 14 and 15 by the conduits 19 and 20, suitable valves being provided as shown so that any number of the refrigeration units may be connected at any one time to provide the capacity desired. While three refrigeration units are shown it will be realized that a greater or lesser number may be provided without departing from the spirit and scope of the invention. The conduit 20 is provided with a pump 21 which may be of any suitable type for circulating cooling water through the coils 16, the pump being driven by an electric motor 38.

In Fig. 2 the refrigerating unit 13 is shown as comprising an ice building tank 24, indicated by phantom lines, having a cooling fluid inlet 25 and a cooling fluid outlet 26. Arranged within the tank 24 are a series of containers 27 and 28,

the containers being connected by suitable conduits 29 and 30, respectively, to a surge tank 30a. Leading to the surge tank 30a is a conduit 22 for conducting liquid refrigerant to the surge tank from a condenser (not shown) and a conduit 23 for conducting vaporized refrigerant to the compressor. The surfaces of containers 27 and 28 are maintained below the freezing temperature of water by the liquid refrigerant vaporizing inside of the container as is well understood.

In the construction of the ice builder tank, space is allowed between the heat exchanger surfaces for ice and water. Ice is not permitted to form solidly between two exchanger surfaces. There is always fluid water. A pump is connected to the tank and water is drawn from the ice builder tank 24 by the pump 21 and forced through the secondary tank 17 and back to the ice builder tank. When it enters the tank it passes through the ice field formed on the heat exchanger surfaces. The tank is so arranged that the returning water must flow over the entire ice field before leaving the tank to again enter the pump. The water returning is warm and it melts some of the ice. As the ice melts it releases its stored up B. t. u. at the rate of 144 B. t. u. per pound of ice. The amount of cooling to be done during a given period determines the amount of ice which must be formed during operation and off hours.

In the case of using ice water for ingredient water or drinking water, water will be added automatically or by hand to replenish ice water used from the tank. This added water will flow through the ice field as in the case of recirculated water. The warm new water will melt the ice and gradually become lowered in temperature as it moves through the ice field.

For recirculating purposes, where the water passes through secondary equipment and back to the ice builder, it is sometimes desired to have a temperature lower than 32°. To obtain a lower temperature it is only necessary to add a calcium chloride, sodium chloride salt or other substance which lowers the freezing point of water. The ice will form at this lower temperature and the delivered water solution will be lower than 32°. The desired temperature is determined by the amount of salt or other chemical added.

Ice will be formed on the outside surfaces of the heat exchanger due to the fact that they are submerged in water and the refrigerating machine removes the gases formed by the refrigerant boiling to maintain a temperature of the refrigerant of less than the freezing point of water or brine solution.

By forming ice on the exchanger surfaces a storage of 144 B. t. u. per pound of water is effected and a great reserve of B. t. u. is stored in a comparatively small space.

Water is used as the cooling fluid which circulates through the coils 16, the conduits 19 and 20 and through the refrigerator tanks and in order to force the water to circulate over the cooling surfaces of containers 27 and 28 the containers are of a dimension to fit with their side edges touching the sides of the tank 24 and arranged in a zigzag fashion, as shown, with the bottom edges of containers 27 sitting on the bottom of the tank 24 and having their top edges below the top edges of the containers 28 which have their bottom edges above the bottom of the tank. Water entering the refrigerator through the inlet 25 connected to conduit 19 circulates, as shown by the arrows, upwardly along the front surface of the first container, downwardly and upwardly respectively between succeeding groups of containers and out through the outlet 26 which connects with conduit 20. During one portion of the operating cycle the water throughout the system does not circulate but remains stationary and during this interval ice 31 forms on the surface of the containers.

The thickness of the ice 31 is indicated by an ice gauge 32 shown in detail in Fig. 3. This gauge comprises a pipe 33 fastened to the ice-forming surface of container 27 in a water-tight manner as by welding, and a plug 34 closing the end of the pipe. Supported by pins inside of the pipe there is a rubber core 35. Leading from the pipe is conduit 36 which may be of any desired length and to the end of which there is attached an ordinary fluid pressure gauge 37. The pipe as well as the gauge itself and the conduit leading from the pipe to the gauge are completely filled with water, care being taken that there are no air bubbles in any part of the ice gauge. When ice forms on the ice building surface of the container 27 the water inside of the pipe freezes also, the freezing taking place first, of course, nearest the freezing surface. As the water freezes it expands as is well known, some of the expansion being absorbed by the rubber core which prevents the pipe from bursting but the remainder of the increase in pressure causes the gauge pointer to deflect, producing an indication of the amount of ice formed on the ice building surfaces.

To produce circulation of the cooling water in the system, power is supplied to the electric motor 38 through the conductors 39 and 40, contacts 41 and 42 being arranged to close the electric circuit. The contacts 41 and 42 are operated by a solenoid 43 which is energized from the conductors 39 and 40 through the conductors 44 and 45 and the contacts 46 and 47 which may be bridged by the ice gauge pointer 48. The pressure gauge is provided with a second set of contacts 49 and 50 which are also adapted to be bridged by the gauge pointer 48 and which are connected to the power lines 39 and 40 through the conductors 51 and 52, the conductor 52 including a solenoid 53 for operating the normally closed set of contacts 54. It is to be noted that a pair of contacts 55 are adapted to be closed, thereby short-circuiting the conductors 44 and 45 whenever the contacts 41 and 42 are closed by the solenoid 43.

In the operation of the cricuit, as described, when the ice reaches the desired thickness, the pointer 48 closes the contacts 46 and 47 supplying power to the solenoid 43 to close the contacts 41 and 42, the switch 56 being closed, thereby energizing the motor 38. The contactor in closing contacts 41 and 42 also closes the contacts 55 to short-circuit the conductors 44 and 45. Therefore the motor continues to operate until the ice thickness has decreased to a point where the pointer 48 bridges the contacts 49 and 50 which energizes the solenoid 53 to open the contacts 54, thereby interrupting the current to the solenoid 43 to effect stopping of the motor.

Operation is as follows: The refrigerator tank is filled with water to a level just above the top edge of the container 27. Refrigerant is supplied from the compressor at all times and thus the outer surfaces of the containers 27 and 28 are always in a condition to freeze ice, the ice forming on the surfaces of the containers in slabs, the thickness depending upon the length of time the system operates. During a portion of the cycle of operation with the switch 56 closed, the

motor 38 is de-energized since the contacts 41 and 42 are open. In this condition ice forms, as explained, on the outer surfaces of the containers 27 and 28 and ice continues to form until its thickness is such that the pointer 48 closes the contacts 46 and 47 when the motor starts and produces circulation of the water through the system. The water, after being cooled by circulation in contact with the ice, flows through the coils 16 and thereby cools the cooler 11. The ice 31, of course, melts since the water coming from the coils 16 is warm and when the thickness of the ice reaches a value such that the pointer 48 bridges the contacts 49 and 50, indicating that the ice is substantially used up, the motor 38 stops, as explained, thereby stopping circulation of the water. Ice will then reform on the surfaces of containers 27 and 28 until the ice has sufficient thickness to cause pointer 48 to again close the contacts 46 and 47 to repeat the cycle.

It will be realized, of course, that the operation of the system may be manual and that the ice gauge may be used to operate a signal light or warning device to indicate that the ice is of a thickness to warrant starting or stopping the operation of the system.

While a particular embodiment of the invention has been shown, it will be understood, of course, that the invention is not limited thereto since many modifications may be made, and it is, therefore, contemplated by the appended claims to cover any such modifications as come within the true spirit and scope of the invention.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. A cooling system comprising a refrigerator having a refrigerant-receiving and heat-transferring device provided with an extensive heat transfer surface on a face thereof and adapted to receive refrigerant for congealing a liquid on said surface, a tank for containing liquid to substantially cover said heat transfer surface, power means for circulating liquid through said tank over said surface, and means for controlling the thickness of the congealed liquid formed on said surface comprising a container for a congealable liquid located so that at least a portion of the container will be within the field of congelation of liquid on said surface, and comprising also pressure responsive means for controlling the operation of said power means in communication with said container and controlled by the change of pressure therein due to the congelation of liquid therein.

2. A cooling system comprising a refrigerator having a plurality of juxtaposed, two-faced refrigerant-receiving and heat-transfering devices, each provided with an extensive heat transfer surface on each face thereof and constructed and arranged to receive refrigerant for congealing a liquid on said surfaces, and means for causing a flow of congealable liquid in one direction along one surface of a first one of said devices and thence in the opposite direction between the opposing surfaces of said first device and a second device.

3. A cooling system comprising a refrigerator having a plurality of juxtaposed, two-faced refrigerant-receiving and heat-transfering devices, each provided with an extensive heat transfer surface on each face thereof and constructed and arranged to receive a refrigerant for congealing a congealable liquid on said surfaces, and means for causing a downward flow of congealable liquid along one surface of a first one of said devices and thence under the lower edge of said first device and upward between the opposing surfaces of said first device and a second device.

4. A cooling system comprising a refrigerator having a plurality of juxtaposed, two-faced refrigerant-receiving and heat-transferring devices, each provided with an extensive heat transfer surface on each face thereof and constructed and arranged to receive a refrigerant for congealing a congealable liquid on said surfaces, and means for causing an upward flow of congealable liquid along one surface of a first one of said devices and thence over the top of said first device and downward between the opposing surfaces of said first device and a second device.

5. A cooling system comprising a refrigerator having a refrigerant-receiving and heat-transferring device provided with an extensive heat transfer surface on a face thereof and adapted to receive refrigerant for congealing a liquid on said surface, a tank for containing liquid to substantially cover said heat transfer surface, means for circulating liquid through said tank over said surface, and means for indicating the thickness of the congealed liquid formed on said surface comprising a container for a congealable liquid located so that at least a portion of the container will be within the field of congelation of liquid on said surface, and pressure-controlled indicating means in communication with said container and controlled by the change in pressure therein due to the congelation of liquid therein.

6. A cooling system comprising a refrigerator having a refrigerant-receiving and heat-transferring device provided with an extensive heat transfer surface on a face thereof and adapted to receive refrigerant for congealing a liquid on said surface, a tank for containing liquid to substantially cover said heat transfer surface, means for circulating liquid through said tank and over said surface, and means for measuring the thickness of the congealed liquid formed on said surface comprising a container for a congealable liquid located so that at least a portion of the container will be within the field of congelation of liquid on said surface, and pressure-controlled measuring means in communication with said container and controlled by the change in pressure therein due to the congelation of liquid therein.

JOSEPH I. MORRISON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,891,714	Jordan	Dec. 20, 1932
1,954,455	Morse	Apr. 10, 1934
2,031,274	McKay	Feb. 18, 1936
2,224,629	Borse	Dec. 10, 1940
2,349,671	Newton	May 23, 1944
2,364,154	Markley	Dec. 5, 1944