April 20, 1948. W. M. KELLER 2,440,098

RAILROAD CAR REFRIGERATED BY DRY ICE AND A SECONDARY REFRIGERATING SYSTEM

Filed Dec. 26, 1946 3 Sheets-Sheet 1

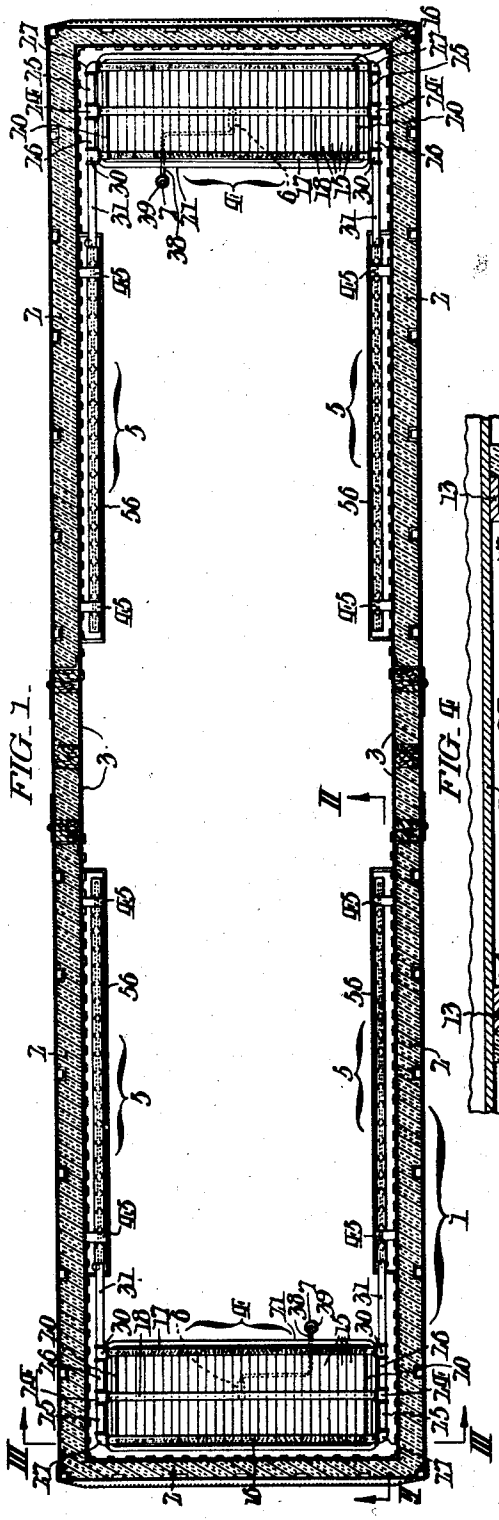


FIG. 1.

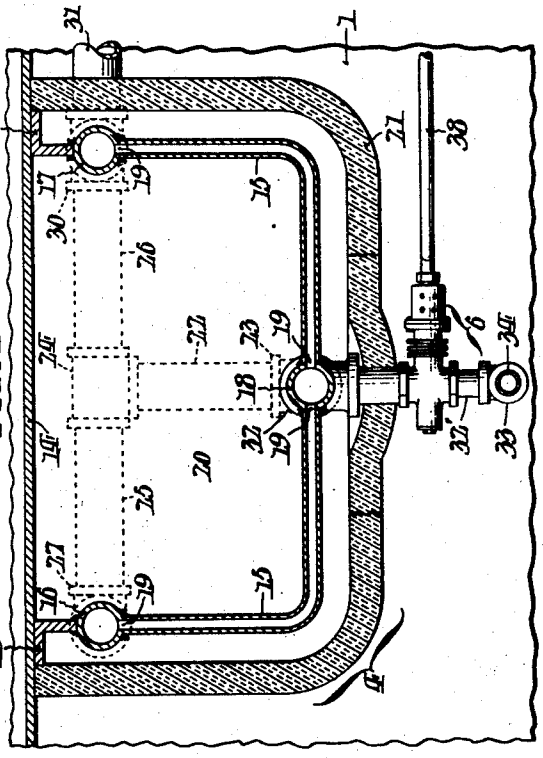


FIG. 4.

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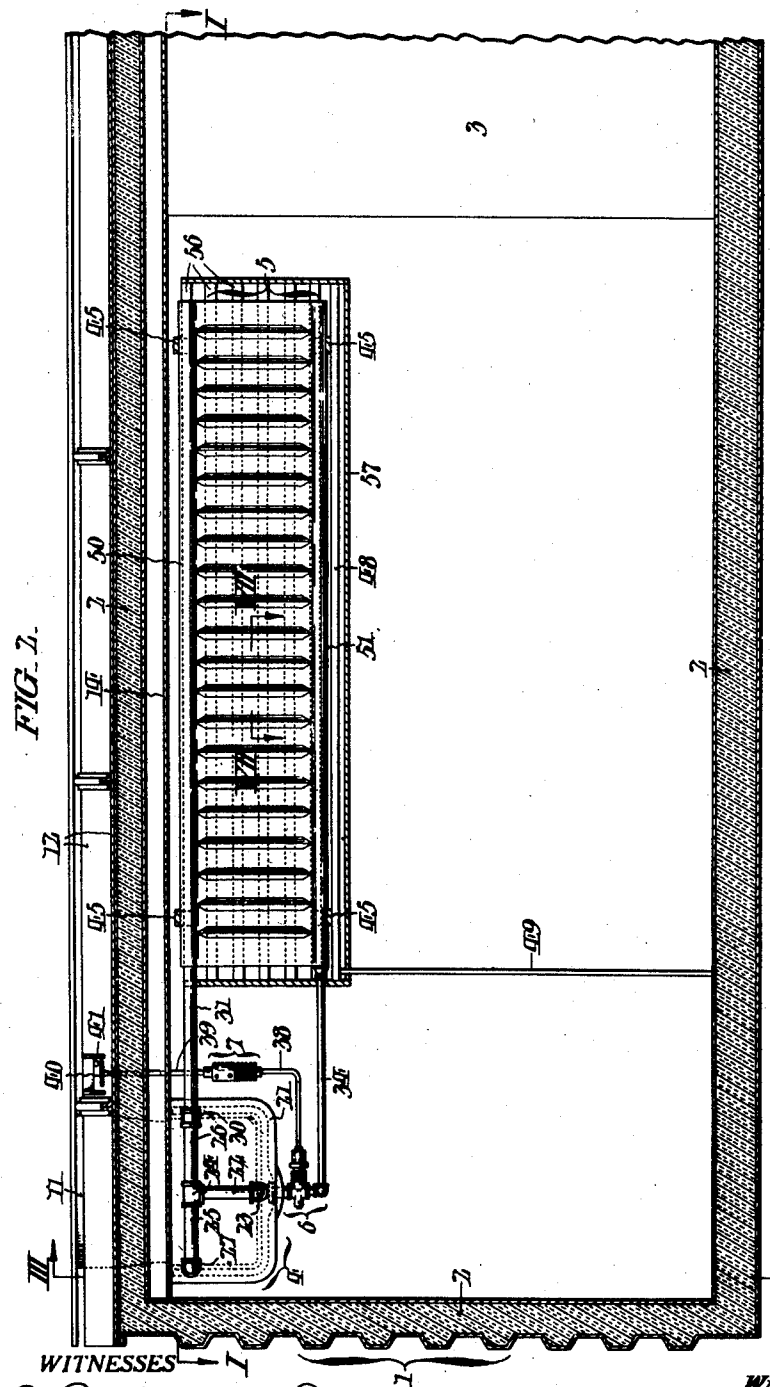


FIG. 2.

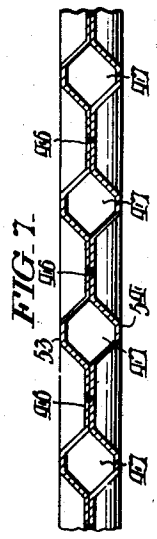


FIG. 7.

WITNESSES

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FIG. 3.

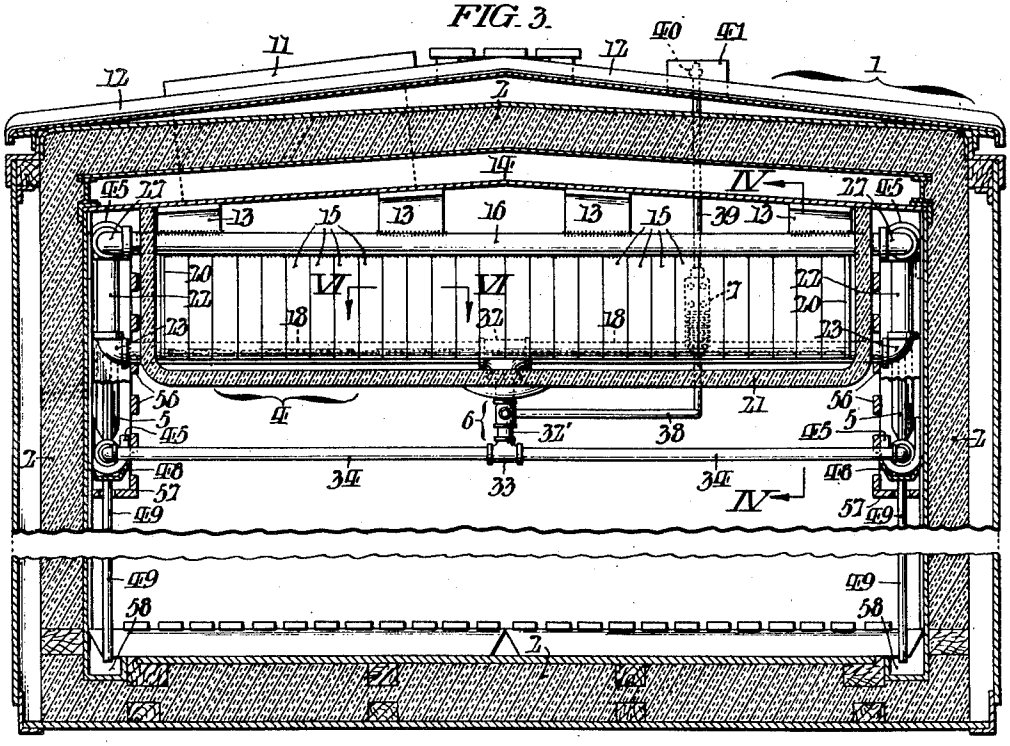


FIG. 5.

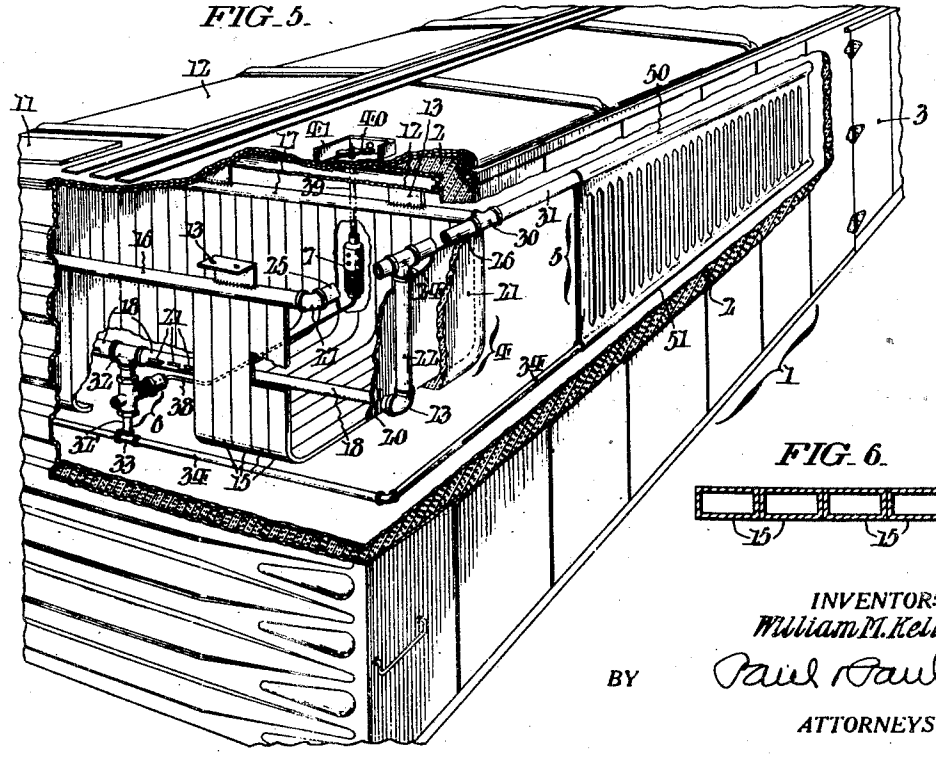


FIG. 6.

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RAILROAD CAR REFRIGERATED BY DRY ICE AND A SECONDARY REFRIGERATING SYSTEM

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Application December 26, 1946, Serial No. 718,400

9 Claims. (Cl. 62—91.5)

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This invention relates to a refrigerating system for a railway car and is directed primarily to such a system which uses a primary refrigerant such as Dry Ice in conjunction with a secondary refrigerant which may be either volatile or non-volatile. In refrigerating systems used in railway cars it is particularly important that the system have rugged and simple structural characteristics because of the severe vibration and shocks to be withstood. It is also important that such systems operate as automatically as possible and yet without complex mechanisms and arrangements which get out of order easily.

Accordingly the main object of my invention is the provision of a refrigerating system for a railway car which is structurally rugged and operationally simple. Another object is the provision in such a system for as much automatic operation as possible in view of the limitations of train crews. Another object is the provision of a system of this type which is extremely sensitive and responsive to changing conditions outside the railway car. Another object is the provision of such a system which is operable with refrigerants of extremely low temperature, such as Dry Ice. Still other objects and advantages of the invention will become apparent from the following description of a practical embodiment of the invention, reference being made to the accompanying drawings.

Of the drawings,

Fig. 1 is a horizontal longitudinal section of a railway freight car equipped with my invention and taken as indicated by the arrows I—I in Fig. 2.

Fig. 2 is a longitudinal section of the end portion of the freight car shown in Fig. 1 and taken as indicated by the arrows II—II of Fig. 1.

Fig. 3 is a transverse fragmented vertical section of the freight car shown in Figs. 1 and 2 and taken as indicated by arrows III—III in those figures.

Fig. 4 is a fragmentary section taken as indicated by the arrows IV—IV in Fig. 3.

Fig. 5 is a perspective view of an end portion of the freight car shown in the preceding drawings with portions broken away to illustrate the construction and operation of the invention.

Fig. 6 is a sectional view taken as indicated by the arrows VI—VI in Fig. 3; and

Fig. 7 is a sectional view taken as indicated by the arrows VII—VII in Fig. 2.

For the purpose of describing a preferred embodiment of this invention, I have shown it as installed in a conventional type of railway refrigeration car 1 equipped internally with insulating material 2 which completely insulates against heat transfer, the top, bottom and walls including side doors 3. It will be observed from the drawings that an operationally separate refrigerating system is provided for each end of the car which reduces by half the risk from an operational failure. Each system is identical in its structure and operation and I will therefore limit the detailed description of my invention to one system in one end of the car which may be analyzed for descriptive purposes into the following main components: an ice bunker 4, cooling evaporators 5, valve 6 and thermostatic valve control element 7. The circulating pipes operationally and structurally tying these elements into the system will be traced later as the detailed description is developed.

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The ice bunker 4 which is mounted in the upper part of the end of the car 1 is given generally a box-like shape in order to provide a receptacle for the primary refrigerant such as Dry Ice or the like. Access to the ice bunker 4 is provided by means of hatch or door 11 in the roof 12 of the car 1 as appears clearly in Fig. 3. The ice bunker 4 is suspended from the roof 12 by means of a number of suspension brackets 13 which are bolted to the inner ceiling 14 of the roof 12 and welded to the ice bunker 4. In order to permit the escape of vapors forming within the ice bunker 4, I provide a conventional form of atmospheric vent which is well known to this art and is therefore not shown in the drawings.

The ice bunker 4 is composed of a number of U-shaped tubes 15 having a rectangular cross section as clearly appears in Figs. 5 and 6. These tubes 15 are spot welded together at their adjacent sides without being gas-tight, and at their ends they are welded to top pipe headers 16 and 17 and to a common bottom header 18. These headers 16, 17 and 18 are formed from pipe stock with openings 19 (see Figs. 4 and 5) to connect and register with the openings in the ends of the tubes 15. The ends of the ice bunker 4 are formed by end sheets 20 welded to the adjacent sides of tubes 15. A layer of insulating material 21 extends completely around the bottom and sides of the bunker 4 in spaced relation thereto and into gas-tight contact with the inner ceiling 14, effectively insulating the primary refrigerant from the lading space of the car 1. This insulating material 21 thus provides a gas-tight enclosure for the ice bunker 4. Since the tubes 15 are welded together without

being gas-tight at the welded joints, cold volatile gases formed within the ice bunker 4 will pass between the tubes 15 into the space between insulation 21 and the outside of the tubes 15. In this way the efficiency of the heat-transfer operation between the primary and secondary refrigerants is increased.

The ends of the headers 16, 17 and 18 are inter-connected on each side of the ice bunker 4 and are connected to the cooling evaporators 5. This inter-connection is accomplished in the following manner. An upright pipe section 22 is connected to an end of the bottom header 18 by elbow 23. The top end of pipe section 22 is fitted with a T-coupling 24, which is connected to the two pipe sections 25 and 26. Section 25 is connected to header 16 by an elbow 27 and section 26 to header 17 by T-coupling 30 which also connects with circulating pipe 31 leading to the top of the evaporator 5. This same system of inter-connection is provided at both ends of the ice bunker 4 and is on the outside of the insulating layer 21, the headers 16, 17 and 18 extending through the insulation layer 21 for that purpose.

The common bottom header 18 is broken at a joint equidistant from the ends thereof and a T-coupling 32 is inserted at that point connecting the two parts of the header 18. Connected to the T-coupling 32 under the header 18, is the valve 6 which is connected also to circulation pipe 34 by means of pipe section 32' and T-coupling 33. It may be noted here that circulation pipe 31 is of a larger diameter than circulation pipe 34 which contributes to the natural circulation of the secondary refrigerant in the circulating system. The natural circulation requires a secondary refrigerant having a low freezing point and a density which varies enough to induce circulation through the system. The relation between the primary and secondary refrigerants and their proper characteristics to effect natural circulation are well understood in the art and need not be further developed here.

The valve 6 operates under the thermostatic control of the control element 7 to which it is connected by pipe 38 as is fully explained in my pending application for U. S. patent, filed September 6, 1946, under Serial No. 695,315. Since the operation and construction of valve 6 and its control element 7 are fully described in the above mentioned patent application, a detailed description thereof will not be necessary or desirable here. Both valve 6 and control element 7 are positioned in the lading space and thermostatic control 7 is subject to a hand control rod 39 having a control handle 40 accessible outside the car 1. The rod 39 extends through the roof 12 as shown in the drawings and the control handle 40 mounted on its outside end is disposed within a protecting well 41. The thermostatic control 7 is subject to the temperature conditions in the lading space and by means of pipe 38, the control 7 causes the valve 6 to be operated in response to temperature changes in the lading space. As valve 6 is opened more of the secondary refrigerant immediately subject to heat transfer action with the primary refrigerant is permitted to flow into circulation pipe 34. In this way the cooling action of the system is increased as the temperature rises in the lading space. A full cycle of operation will be described later.

The cooling evaporators 5 are supported on the sides of the car 1 by appropriate brackets 45. Running the length of the evaporator 5, trough-

like strips 48 function as drainage channels and have end walls (not shown) and drain pipes 49 which discharge into gutters 58 formed in the floor of the car 1 where the side walls and floor come together. There are two evaporators 5 connected to each ice bunker 4 by means of circulation pipes 31 and 34. These evaporators 5 are constructed from two preformed metal sheets 53 and 54 which are welded together along their adjacent edges, see Fig. 7. Each sheet has a number of parallel channels or depressions 46 formed therein and of such depth that the bottoms of channels 46 of the two assembled sheets are in contact. By spot welding the contacting bottoms of channels 46, separate parallel flow conduits 47 are formed between the contacting channels 46. Rounded headers 50 and 51 are formed at the top and bottom of the evaporator 5 by welding together the preformed top and bottom edges of the sheets 53 and 54. In the preforming of the sheets 53 and 54, the top and bottom edges are formed with semi-circular channels which form the rounded header when assembled as described above. These headers 50 and 51 are connected with circulating pipes 31 and 34. A wooden slat-work 56 having a bottom member 57 is provided in spaced relation from and parallel to the inner face of the evaporator 5.

The operation of my invention involves the natural circulation of the secondary refrigerant from the ice bunker 4 where it is in heat exchange relation with the primary refrigerant, to the cooling evaporators 5 where it absorbs heat from the lading space, expands and rises to the top of the evaporator 5 and then returns to the ice bunker 4 where heat is transferred from the secondary to the primary refrigerant. The flow may be traced as follows through one of the cooling evaporators: from the valve 6, under the control of thermostatic control elements 7, through pipe 32' into pipes 34 where the flow divides and goes to both evaporators 5, to bottom header 51 of evaporator 5, up through flow passages 47 of evaporator 5 into top header 50, through pipe 31, to header 17 and through pipes 25 and 26 to header 16 of ice bunker 4, down tubes 15 and pipe 22 to bottom header 18 and then into valve 6, thus completing the circulatory circuit through one of the evaporators 5. The flow through the other evaporator 5 is identical and goes on simultaneously with the flow just described. The thermostatic control element 7 is set for desired temperature ranges by means of the control handle 40 which is accessible to a trainman on the roof of the car. One trainman can thus efficiently control a number of refrigeration cars equipped with my refrigeration system.

My invention thus provides an operationally and structurally simple refrigerating system adapted to the rugged requirements of a railway refrigeration car. It is capable of automatic control within set temperature ranges which may be controlled from outside the car. Due to the fact that a plurality of operationally independent systems are provided in a car, the risk to the contents of the car from failures in refrigeration is greatly reduced.

While I have described the preferred form of my invention in considerable detail, it will be apparent to those skilled in the art that various modifications and changes may be made therein without departing from the spirit and substance of the invention as hereinafter claimed.

I claim:

1. The invention of claim 9 characterized fur-

ther by the fact that said control valve is subject to a thermostatic control element responsive to temperature variations in the lading space of the car, and that the thermostatic control element has a hand control means for setting the temperature ranges of the thermostatic control, said hand control means being operable from outside the car.

2. In combination with a railway refrigeration car a refrigeration system comprising an insulated ice bunker having heat transfer pipes connected to top headers and a common bottom header, a cooling evaporator disposed within the lading space of the car, a thermostatic control valve connected to the common bottom header and responsive to temperature variations in the lading space of the car, a circulating pipe connecting the top headers to the top of the evaporator and a circulating pipe connecting the control valve to the bottom of the evaporator.

3. The invention of claim 2 characterized further by the fact that said top and bottom headers are interconnected at the ends thereof.

4. The invention of claim 2 characterized further by the fact that said heat transfer pipes are rectangular in cross section and are welded together to form the sides and bottom of said ice bunker and that the ends of said ice bunker are formed by end sheets attached to said heat transfer pipes.

5. The invention of claim 2 characterized further by the fact that said ice bunker is insulated from the lading space of the car by a layer of insulation mounted on the outside of said ice bunker.

6. The invention of claim 2 characterized further by the fact that a drainage channel is provided under said cooling evaporator and said

drainage channel has a drainage pipe leading downwardly therefrom to discharge into a drainage canal formed in the floor of said car.

7. The invention of claim 2 characterized further by the fact that the pipe connecting the top headers with the evaporator is larger in diameter than the pipe connecting the bottom of the evaporator with the control valve.

8. The invention of claim 2 characterized further by the fact that said ice bunker is positioned within a gas tight heat insulated receptacle and in spaced relation therewith and by the fact that the joints between adjacent heat transfer pipes in said ice bunker are not gas tight whereby gas within said ice bunker may flow into the space between the inner surface of said insulated receptacle and the outer surfaces of said heat transfer pipes.

9. In combination with a railway refrigeration car, a refrigeration system comprising top and bottom headers supported within the car, heat transfer pipes connected to said top and bottom headers and being formed to provide an ice bunker, a cooling evaporator disposed within the lading space of the car, a control valve connected to the bottom header, a circulating pipe connecting the top headers to the top of said evaporator and a circulating pipe connecting said control valve to the bottom of said evaporator.

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

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