May 30, 1933. R. E. ROBILLARD 1,912,333

REFRIGERATING APPARATUS

Filed Feb. 26, 1931 2 Sheets-Sheet 1

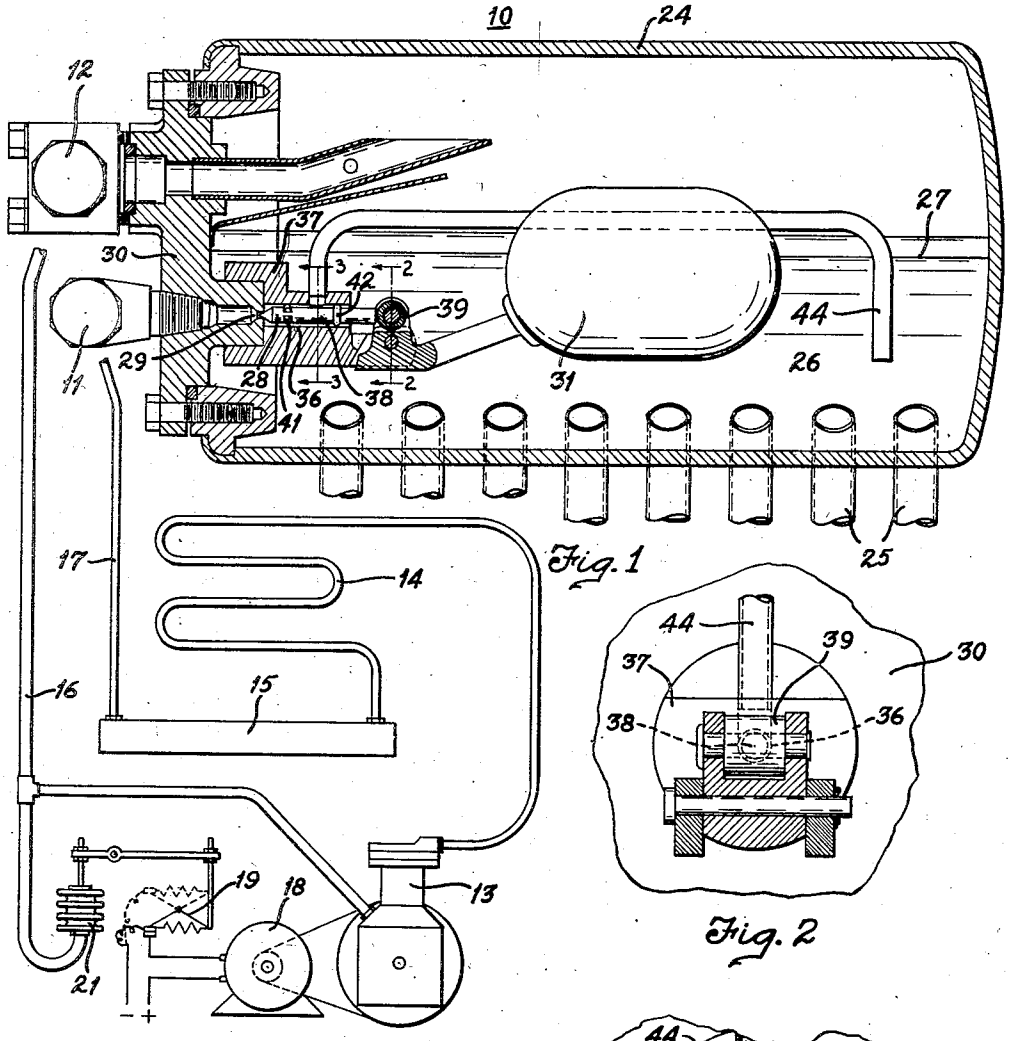


Fig. 1

Fig. 2

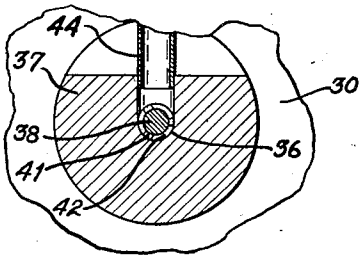


Fig. 3

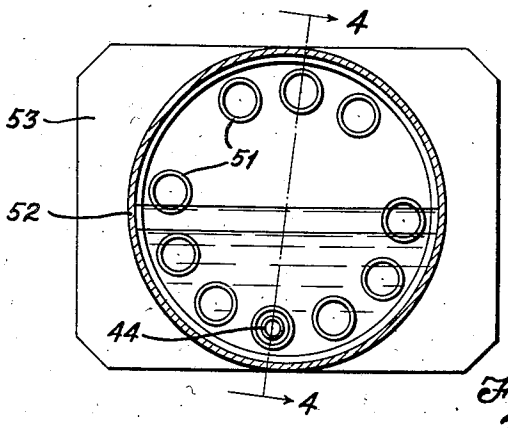


Fig. 6

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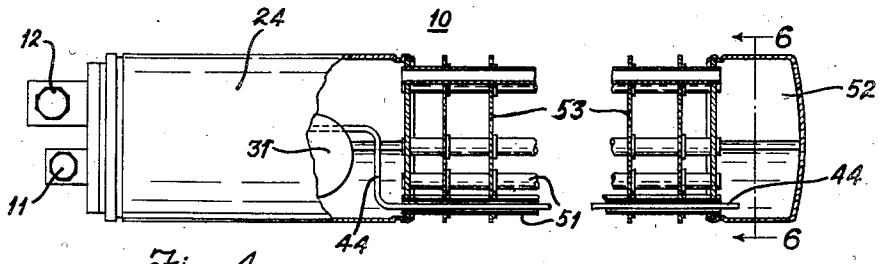


Fig. 4

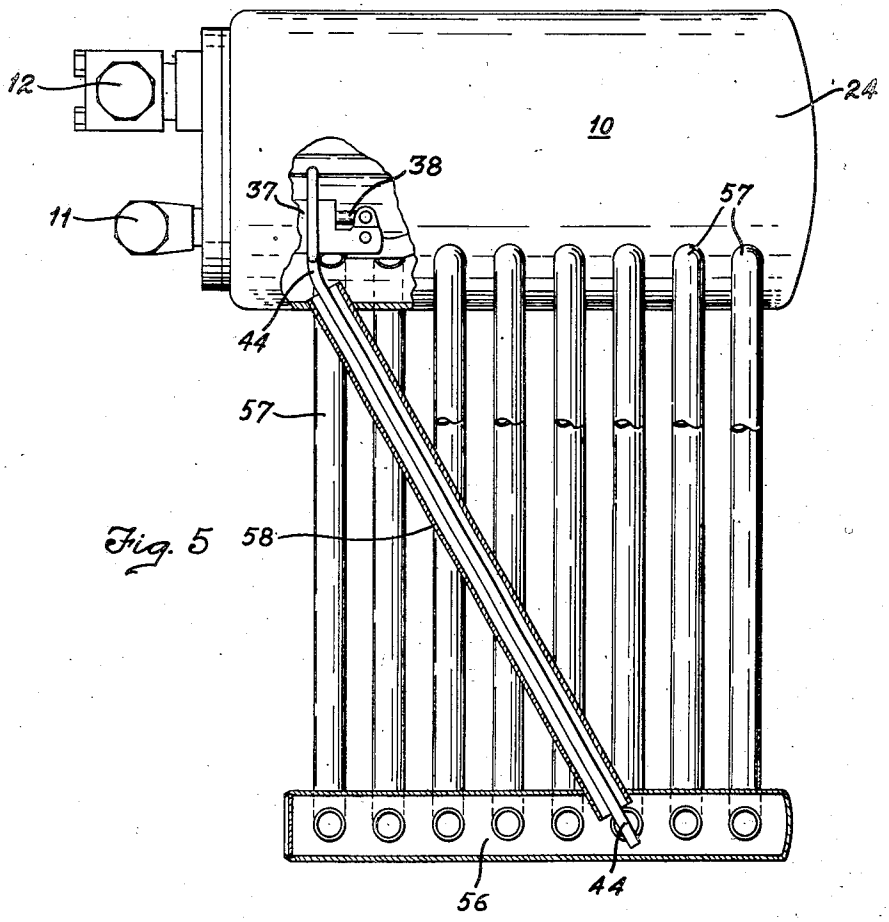


Fig. 5

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UNITED STATES PATENT OFFICE

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REFRIGERATING APPARATUS

Application filed February 26, 1931. Serial No. 518,456.

The present invention relates to refrigerating apparatus and more particularly to refrigerating apparatus of the compression type wherein a lubricant is circulated in a closed cycle with the refrigerant.

Heretofore in refrigerating systems of the compression type trouble has been experienced because oil employed to lubricate operating parts of the system has accumulated on the walls and on top of the liquid refrigerant within the evaporator. This accumulation of oil on the walls and within the evaporator becomes very viscous, as the temperature of the evaporator is reduced, and forms a thick layer or blanket on the refrigerant which hinders or retards evaporation of the liquid refrigerant contained in the evaporator.

The object of the present invention is to provide means whereby the collection of oil within an evaporator of a refrigerating system will not hinder normal evaporation of refrigerant contained therein.

Another object of the present invention is to utilize the energy expended by the partial evaporation or flashing of refrigerant entering an evaporator for agitating the liquid refrigerant at a plurality of points within the evaporator to cause circulation of refrigerant therethrough.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a vertical section through a portion of an evaporator having my invention embodied therein and having a refrigerating system shown diagrammatically adapted to be connected with the evaporator;

Fig. 2 is a fragmentary sectional view of a portion of a mechanism contained in the evaporator taken on the lines 2—2 of Fig. 1;

Fig. 3 is a fragmentary sectional view of a portion of the evaporator taken on the lines 3—3 of Fig. 1;

Fig. 4 is a view taken on the lines 4—4 of Fig. 6 showing a modified form of an evaporator partly in section and partly in elevation and having my invention embodied therein; and

Fig. 5 is a view partly in section and partly in elevation of another modified form of an evaporator having my invention embodied therein; and

Fig. 6 is a sectional view taken on the line 6—6 of Fig. 4.

For the purpose of illlustrating the present invention I have shown in Fig. 1 a compressor-condenser-expander type of refrigerating system having an evaporator 10 shown in section on a large scale and including connections 11 and 12 for operatively connecting the evaporator with the system. In addition to the evaporator the system includes a compressor 13, a condenser 14 and a reservoir or liquid refrigerant tank 15. Refrigerant vapor is withdrawn from the evaporator 10 through the vapor or low pressure conduit 16 and is liquefied in the condenser 14 and returned to the evaporator through the liquid or high pressure conduit 17. The compressor is operated by a motor 18 controlled by an automatic switch 19 which may be actuated in response to the refrigerating demand, for example by a pressure-responsive device 21 connected to the low pressure conduit 16. It is obvious, in systems of the type disclosed, to state that the pressure-responsive device 21 which actuates the switch 19 for controlling the electric circuit to the motor is adjusted to operate between certain pressure limits. Since pressures and temperatures of the refrigerant increase or decrease uniformly it is apparent that the device 21 is adapted to maintain certain predetermined temperature limits within the evaporator of the system.

Referring to Fig. 1, evaporator 10 comprises a header 24 forming a reservoir for liquid refrigerant, and a plurality of ducts 25 depending from the header 24 for circulating refrigerant to a point remote from the reservoir. The liquid refrigerant indicated at 26 is kept at a constant level 27 by a valve 28 which controls a liquid refrigerant inlet opening 29 extending from the connection 11 through an end plate 30. Valve 28 is actuated in response to the liquid refrigerant

level by a float 31. The liquid refrigerant is supplied to the evaporator through the inlet connection 11 and the vapor or gaseous refrigerant is withdrawn through the connection 12 connected to the vapor conduit 16.

The apparatus, or system, as generally described above is lubricated by placing a quantity of oil in the crankcase of the compressor and depending upon the splashing of the rotating parts to distribute oil throughout the compressor. Some of the oil is dissolved in the refrigerant and some of the oil is mechanically pumped by the compressor to the condenser and reservoir and eventually to the evaporator. The oil in separating by gravity from the refrigerant in the evaporator forms globules which adhere to the walls thereof and tend to remain stationary. These globules of oil form a layer of insulation between the liquid refrigerant in the evaporator and the wall thereof which insulation retards the conduction of heat from the evaporator wall to refrigerant contained therein and consequently evaporation of the refrigerant is also retarded. Finally after the refrigerant absorbs sufficient heat to cause its evaporation a disturbance occurs in the evaporator and the globules of oil are carried to the top of the liquid refrigerant. The refrigerant continues to boil off in the evaporator, leaving the oil, which collects in a layer of from ½" to 1¼" thick on top of the refrigerant.

This collection or accumulation of oil in the evaporator is particularly harmful when the system is used to refrigerate an ice cream cabinet or the like, wherein very low temperatures are desired to be maintained. Under such conditions within the evaporator of the system the compressor will be operated frequently and only for short intervals of time thus causing short operating cycles of the compressor. These "short cycles" of the compressor are caused by the compressor creating a suction in the low pressure conduit 16 and in the space above the liquid level within the header 24 of the evaporator, sufficient to cause the pressure-responsive device 21 to actuate the automatic switch 19 and break the electric circuit to the motor 18 thus stopping the compressor, without breaking up the layer of oil in the evaporator thereby preventing liquid refrigerant below the layer of oil from vaporizing. Obviously such short cycles of the compressor will continue indefinitely and the evaporator will not be reduced to the temperature at which pressure-responsive device 21 has been set to maintain therein. Consequently the motor which drives the compressor is started an abnormal number of times causing overheating thereof. Furthermore, the refrigerating efficiency of the evaporator becomes decreased thereby permitting the temperature within the compartment in which the evaporator is located to increase. This inefficient operation of a system will not maintain substances cooled thereby at the desired temperature and is very likely to permit the substances to deteriorate.

My invention is directed to a system whereby the refrigerant beneath the layer of oil in the evaporator is positively and intermittently agitated at a plurality of points in the evaporator sufficient to cause the blanket or layer of oil to be broken up. This thereby permits liquid refrigerant within the evaporator to vaporize and prevents the compressor from reducing the pressure in the space above the layer of oil and in the low pressure conduit to a degree sufficient to effect the pressure-responsive device until the desired low temperature of the evaporator has been obtained. I provide a device which utilizes the energy expended by liquid refrigerant entering the evaporator, of which a portion immediately flashes into vapor as it enters the header which is maintained at a low pressure, for breaking up the oil blanket at a plurality of points in the evaporator. In breaking up the blanket of oil at a plurality of points in the evaporator my device also more efficiently returns some of the oil to the compressor thus preventing the evaporator from becoming entirely oil-logged.

Referring now to Fig. 1, I have provided a means to agitate the liquid within the evaporator at a plurality of points and this means includes two outlets for incoming liquid refrigerant disposed below the liquid refrigerant level in the evaporator. The liquid refrigerant inlet opening 29 leading to the interior of the header 24 includes a relatively long passage 36 provided in the member 37 to which the arm of float 31 is pivotally mounted.

The valve 28 which controls the inlet opening 29, in response to the movement of the float 31, has a stem portion 38 extending through the passage 36. A roller 39 secured to the arm of float 31 is adapted to engage the end of the stem portion 38 for moving the valve 28 into engagement with its seat. It is to be understood that this valve 28 is opened by pressure of the refrigerant in advance of the valve when the float 31 falls and causes the roller 39 to disengage the stem portion 38 of the valve. Valve stem portion 38 has two enlargements 41 and 42 formed thereon which serve to guide the valve 28 in horizontal alignment with its seat. The enlargement 41 is slotted as at 43 (see Fig. 3) to permit the incoming liquid refrigerant to freely flow past it. A tube or conduit 44 which may be made of a flexible material is soldered or otherwise secured to an opening in member 37 which opening communicates with the passage 36. This tube extends around the float 31 to a point remote from the inlet opening and near the rear of the header and has its end dis-

posed below the liquid refrigerant level maintained within the reservoir formed by the header. The enlargement 42, formed on the valve stem portion 38, is circular in cross-section and is not slotted but is machined to provide a sliding fit within the passage 36. The sliding fit of the enlargement 42 permits a quantity of incoming liquid refrigerant to flow past this enlargement. It is thus apparent that the inner end of the passage 36 and the tube or conduit 44 provides two spaced apart outlets for distributing incoming liquid refrigerant to the reservoir or evaporator below the liquid level maintained therein. It is also apparent that the fit of the enlargement 42 within the passage 36 forms a restriction in that passage thereby causing an unequal flow of liquid refrigerant through the outlets for the incoming refrigerant. However, it may be desirable to cause a greater flow of refrigerant through the passage 36 than through the tube or conduit 44 and this may be accomplished by providing slots in the enlargement 42 together with the use of a tube of much smaller diameter in the place of tube 44. The tube 44 being secured as disclosed to the member 37 carried by the end plate 30 can be removed from the evaporator as a unit when the plate 30 is removed and the elements secured thereto are withdrawn from the header.

In the operation of the system, compressor 13 and condenser 14 liquefies the refrigerant which is then collected in the liquid receiver 15 together with lubricant passing from the compressor. The liquid refrigerant together with the dissolved lubricant are admitted by means of the float actuated valve 28 into the header 24, and, as the refrigerant is evaporated, the gaseous refrigerant is returned through the connection 12 and conduit 16 to the compressor 13. The oil in header 24 of evaporator 10 floats on top of the liquid refrigerant after it has separated from the liquid refrigerant by concentration through the constant evaporation of the refrigerant. The layer of oil on top of the refrigerant in the evaporator becomes more viscous as the temperature of the evaporator is reduced. Since the liquid refrigerant within the evaporator is agitated by the immediate vaporization of a portion of the incoming refrigerant at a plurality of points within the evaporator this layer of oil is intermittently broken up and thus permits liquid refrigerant therein to vaporize and be returned to the compressor. Any evaporation of refrigerant from the body of liquid in the reservoir will cause the level therein to fall and consequently the float will drop permitting the inlet valve to open to let more liquid refrigerant into the reservoir. It is thus apparent that if the evaporator is producing any refrigerating effect whatever my improved device will function to keep the oil blanket in a state of continuous agitation and thus short operating cycles of the compressor as heretofore described are prevented.

In Fig. 4, I have shown a modified form of evaporator embodying my invention. The construction and arrangement of the evaporator shown in Fig. 4 is fully described in a copending application of Jesse G. King, Serial No. 236,718, filed November 30, 1927, and for this reason it will only be briefly described here. Ducts 51 extend horizontally from the header 24 and communicate with a second header 52. Fins 53 traverse the refrigerant conveying ducts 51 for increasing heat conduction to the refrigerant within the ducts. The header 52 may be spaced any desired distance from the header 24. The mechanism within the header 24 is identical to the mechanism previously described and shown in the evaporator in Fig. 1, except that the tube 44 is made much longer so that it will reach into or through one of the ducts 51 to within or near the header 52. By agitating the liquid refrigerant at a plurality of points within an evaporator of the type disclosed in Fig. 4 an efficient circulation of refrigerant therein is obtained and the evaporator will have a substantially uniform temperature throughout its length regardless of the distance between the headers 52 and 24.

In Fig. 5, I have shown another modified form of evaporator embodying my invention. In this form the header 24 of the evaporator contains the mechanism heretofore described and shown in Fig. 1 and includes a second header or manifold 56 disposed below the header 24. Ducts 57 extend outwardly and interconnect the header 24 and the manifold 56. In order to agitate the liquid refrigerant within the ducts 57 and within the manifold 56 in addition to within the header 24, I provide a duct 58 which also interconnects the header and the manifold. This duct 58 is secured to the bottom of the header 24 near the front end thereof and extends at an angle rearwardly and down to the manifold 56. The tube 44 in this modified evaporator structure is also made much longer than that shown in the evaporator disclosed in Fig. 1 in order to permit the tube 44 to be inserted into the duct 58 when assembling the float valve mechanism into the header so that it will extend through the duct 58 into or to a point near the manifold 56. It is obvious of course that the tube 44 in this instance must be made of flexible material to permit such insertion thereof. As before pointed out with respect to the evaporators shown in Figs. 1 and 4, the circulation of refrigerant in all the ducts 57 leading from the manifold 56 in this modification will be greatly increased by the agitation thereof at a plurality of points within the evaporator and particularly by the agitation of the refrigerant in the manifold 56.

From the foregoing it is apparent that I have provided an apparatus which is sure in its operation and which functions efficiently when the system is operating to maintain a very low temperature, which low temperature increases the viscosity of the lubricant, while at the same time providing a means for preventing the lubricant from retarding evaporation of liquid refrigerant in the evaporator. My improved apparatus, by causing disturbance or agitation of the liquid refrigerant, insures positive and regular circulation of refrigerant through the evaporator. With this accomplished evaporators of the type disclosed are rendered more efficient for producing very low temperatures. Likewise the life of the compressor and its operating motor is prolonged by the prevention of the heretofore described short operating cycles thereof.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. A refrigerating system comprising an evaporator and a refrigerant liquefying unit operatively connected with the evaporator for circulating a refrigerant therethrough, said evaporator forming a reservoir for liquid refrigerant and lubricant lighter than the liquid refrigerant and adapted to float thereon in a layer, a duct extending from and communicating with said reservoir for receiving liquid refrigerant therefrom and for delivering liquid refrigerant to a point in said evaporator remote from said reservoir, said evaporator also having a liquid refrigerant inlet opening, a valve for controlling the ingress of refrigerant through said opening, means for actuating said valve, and means for breaking up the layer of lubricant at a plurality of points in the evaporator, said means communicating with said inlet opening for delivering a portion of incoming refrigerant from the opening controlled by the valve to a point below the lubricant level in said evaporator.

2. A refrigerating system comprising an evaporator and a refrigerant liquefying unit operatively connected with the evaporator for circulating a refrigerant therethrough, said evaporator forming a reservoir for liquid refrigerant and lubricant, a duct extending downwardly from and communicating with said reservoir for receiving liquid refrigerant therefrom and for delivering liquid refrigerant to a point below said reservoir and remote therefrom, said evaporator also having a liquid refrigerant inlet opening, a valve for controlling the ingress of refrigerant through said opening, means for actuating said valve, and means for agitating the liquid at a plurality of points in the evaporator, said means communicating with said inlet opening for delivering a portion of incoming refrigerant from the opening controlled by the valve to said lower remote point below the liquid level in said evaporator.

3. A refrigerating system comprising an evaporator and a refrigerant liquefying unit operatively connected with the evaporator for circulating a refrigerant therethrough, said evaporator forming a reservoir for liquid refrigerant and lubricant, a duct extending horizontally from and communicating with said reservoir for receiving liquid refrigerant therefrom and for delivering liquid refrigerant to a point in said evaporator remote from said reservoir, said evaporator also having a liquid refrigerant inlet opening, a valve for controlling the ingress of refrigerant through said opening, means for actuating said valve, and means for agitating the liquid at a plurality of points in the evaporator, said means communicating with said inlet opening for delivering a portion of incoming refrigerant from the opening controlled by the valve to said remote point below the liquid level in the evaporator.

4. A refrigerating system comprising an evaporator and a refrigerant liquefying unit operatively connected with the evaporator for circulating a refrigerant therethrough, said evaporator forming a reservoir for liquid refrigerant and lubricant, a duct extending from and communicating with said reservoir for receiving liquid refrigerant therefrom and for delivering liquid refrigerant to a chamber remote from said reservoir, said evaporator also having a liquid refrigerant inlet opening, means for preventing the rising of liquid within the chamber above a predetermined level, and means for agitating the liquid at a plurality of points in the evaporator, said means communicating with said inlet opening for delivering a portion of incoming refrigerant from said opening to said chamber.

5. A refrigerating system comprising an evaporator and a refrigerant liquefying unit operatively connected with the evaporator for circulating a refrigerant therethrough, said evaporator including an upper and a lower header, ducts interconnecting said headers, said headers together with said ducts forming a reservoir for liquid refrigerant and lubricant, said evaporator having a liquid refrigerant inlet opening, means for preventing the rising of liquid within the evaporator above a predetermined level, means communicating with said inlet opening and providing an outlet for delivering a portion of incoming refrigerant from said inlet opening to a point within said lower header remote from said inlet opening, said outlet being arranged to cause agitation of the liquid in said lower header.

6. A refrigerating system comprising an

evaporator and a refrigerant liquefying unit operatively connected with the evaporator for circulating a refrigerant therethrough, said evaporator forming a reservoir for liquid refrigerant and lubricant, said evaporator also having a liquid refrigerant inlet opening disposed below the level of liquid in said reservoir, a valve for controlling the ingress of liquid refrigerant through said opening, means for actuating said valve to maintain the level of liquid in said reservoir above said inlet opening, and means for conducting the incoming liquid refrigerant from the opening controlled by the valve to a plurality of points in the evaporator without permitting said incoming refrigerant to communicate with the free space above the liquid in the evaporator, said last named means communicating with said inlet opening and providing spaced apart outlets disposed below the liquid level in the evaporator.

In testimony whereof I hereto affix my signature.

ROBERT E. ROBILLARD.