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REFRIGERATING SYSTEM

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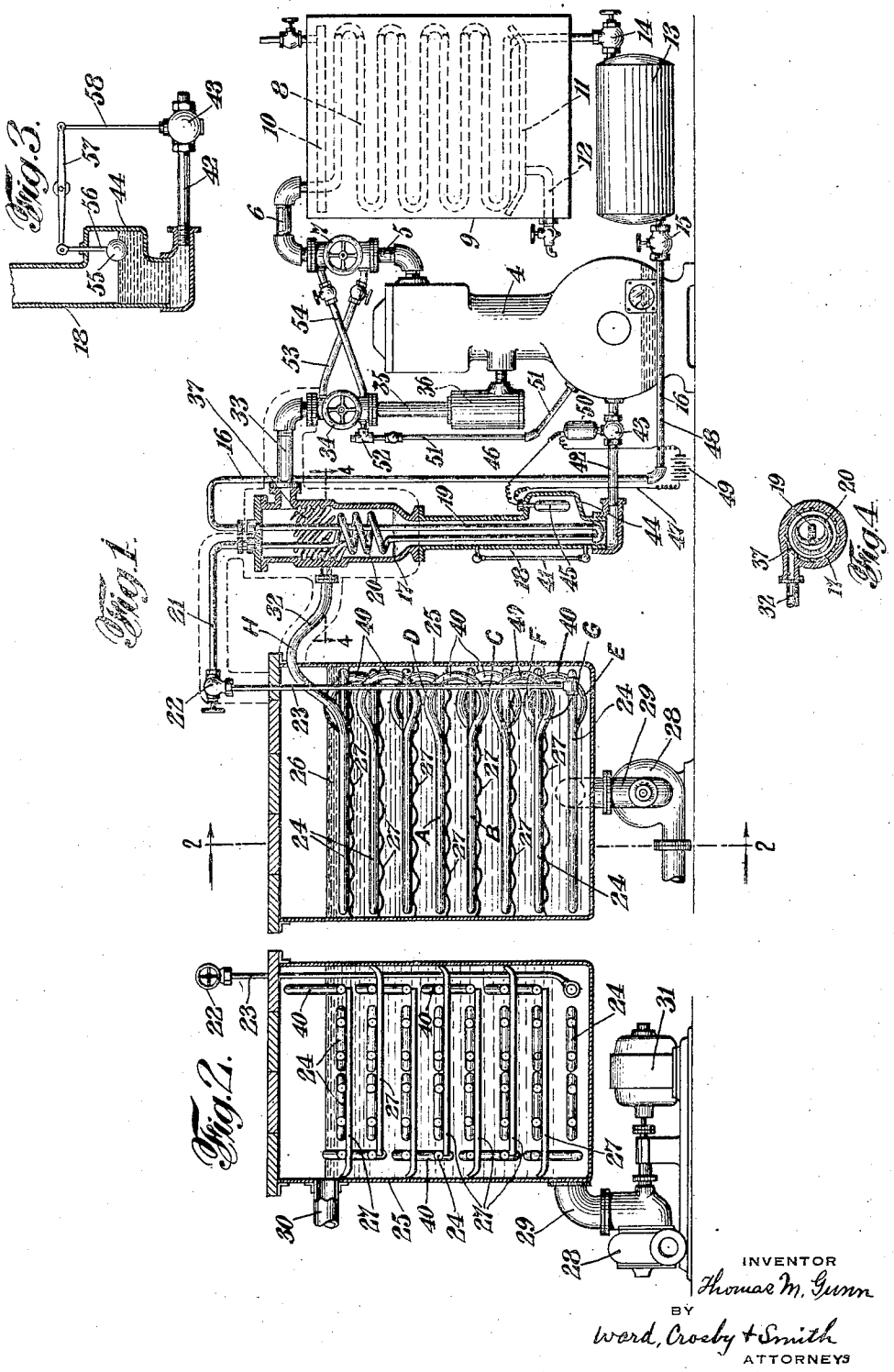


Fig. 1.

Fig. 3.

Fig. 4.

Fig. 2.

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UNITED STATES PATENT OFFICE

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REFRIGERATING SYSTEM

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My invention relates to improvements in refrigerating systems and more particularly to refrigerating systems wherein a refrigerant is compressed and liquefied in one part of the system and is caused to vaporize in the refrigerating or cooling part of the system, and the refrigerant is one in which the lubricant used in the compressing means is soluble.

In refrigerating systems where a refrigerating agent is compressed by a compressor and liquefied and then permitted to vaporize and expand to effect the cooling it is found that more or less of the lubricating oil used in the compressor becomes mixed with the refrigerant and is carried along thereby into the refrigerating coils of the system, from which it must be periodically removed. When a refrigerating agent, such as ammonia, is used in which the lubricant is not soluble, the lubricant settles out at the bottom in various parts of the system and may be practically separated from the refrigerant by simply drawing it off. When, however, a refrigerant is used, such as ethyl or methyl chloride, ether, methane, propane, alcohol, etc., in which the lubricating oil is more or less soluble, removal of the lubricating oil therefrom is attended with great difficulty. This has been done by withdrawing the lubricant laden refrigerant from the system and when a suitable amount has been collected, distilling the refrigerant from the lubricant and returning one or both to their respective parts of the system or otherwise disposing thereof. This necessitates expensive additional apparatus and labor and involves the collection and accumulation of substantial quantities of lubricant in the refrigerating coils which considerably reduces the efficiency of the system.

According to my invention I provide for the substantially continuous removal of lubricant from such refrigerants and in a simple and efficient manner. Further and more specific objects, features and advantages will more clearly appear from the detail description given below taken in connection with the accompanying sheet of drawings which form a part of this specification.

In the drawings Fig. 1 is a vertical view, largely diagrammatical with some parts shown in section, of a system embodying my improvements in one form. Fig. 2 is a vertical section taken on the line 2—2 of Fig. 1. Fig. 3 is a detail illustrating a modification, and Fig. 4 is a detail section taken on the line 4—4 of Fig. 1.

Referring to the drawings 4 represents a compressor driven by any suitable source of mechanical energy (not shown) for compressing the refrigerating agent and forcing it out through a pipe 5 connected with pipe 6 by valve 7, the compressed refrigerant passing from pipe 6 into coils of cooling pipes 8 in a cooling tank or condenser 9. To cool and liquefy the refrigerant in the coils 8 cold water is sprayed down over the coils 8 from a pan 10, the water being collected in a pan 11 at the bottom and withdrawn therefrom through pipe 12. The liquefied refrigerant under pressure passes from the coils 8 into a receiving tank 13 through a valve 14. From the receiving tank 13 the liquid refrigerant passes through a valve 15 into pipe 16.

17 represents an elongated vertical collecting chamber the lower portion of which is reduced in cross section as at 18. The pipe 16 leads to this chamber and is connected with a leg 19 extending down into the reduced portion 18 of the chamber and substantially to the bottom thereof. The other end of the pipe leg 19 is connected with a pipe coil 20 in the upper part of the chamber. The compressed and liquefied refrigerant after passing through pipes 16 and 19 and coil 20 enters pipe 21 through which the refrigerant, still under high pressure, passes to the expansion valve 22 which may be of any well-known or suitable kind. From the expansion valve 22 the refrigerant passes through pipe 23 into refrigerating coils 24 in a tank 25. In the illustration shown the tank 25 is filled with brine 26 adapted to be cooled by the refrigerant in the pipe coils 24. A pump 28 is connected to the bottom of the tank 25 by pipe 29 for withdrawing the cooled brine from the tank, whence it is pumped through refrigerating pipes elsewhere and returned

to the tank 25 through pipe 30. The tank is provided with corrugated sheet metal baffles 27 which cause the brine to take a lateral back and forth movement in passing through the tank 25 so as to obtain a more thorough cooling therein. The pump 28 may be driven by a motor 31.

After passing in a general upward direction through the coils 24 wherein the refrigerant is gradually and largely vaporized by the absorption of heat from the incoming brine, the refrigerant passes out through pipe 32 and into the upper part of the chamber 17. The upper portion of the chamber 17 is connected to the suction side of the compressor by pipe 33, valve 34 and pipe 35, a scale trap being included at 36. Due to the expansion and volatilization of the refrigerant in the coils 24 and the suction action of the compressor on the chamber 17, the volatilized refrigerant travels through the coils 24 and into the chamber 17 at fairly high velocity and with any entrained liquid carried, thereby, enters the enlarged space within the chamber 17 where the liquid has an opportunity to become separated and fall downward, while the gaseous refrigerant rises and passes by the pipe 33 to the suction of the compressor. The separating effect is enhanced as shown in Fig. 4 by the entrance of the pipe 32 into the chamber 17 in a tangential direction and the impinging of the gas in rotation within the chamber 17 against spiral grooves so disposed as to deflect it downward.

For certain installations the use of alcohol, ether, ethyl or methyl chloride methane, propane or butane or the like, as refrigerant has certain advantages over the use of ammonia even though the lubricant used in the compressor is more easily removed from the latter, and as my system is especially designed for use of the former it will be so described. The refrigerant being compressed in the compressor carries away with it more or less of the lubricating oil necessarily used in the compressor. The oil being more or less soluble in the refrigerant which is thoroughly liquefied in the coils 8 passes therethrough with the refrigerant into the receiving tank 13 and so on through the pipes 16, 19, 20, 21 and 23 into the expansion and cooling coils 24. Here, due to the vaporation of refrigerant, the remaining liquid refrigerant becomes more and more saturated with lubricant, the oil laden refrigerant tending to settle and collect in the lower coils 24. This considerably decreases the efficiency of the system since it tends to retard the circulation, interferes with the free evaporation of the refrigerant and increases the boiling point of the mixture. Normally the refrigerant is vaporized gradually throughout its travel up through the various layers of horizontal pipe coils 24, and in order that any entrained oil shall be carried along with it and out into the chamber 17, I provide in the pipes 24 a plurality of traps to prevent liquid in the pipes from running down counter to the general movement of vaporized refrigerant whereby liquid lubricant in the pipes is forced along through the pipes and out thereof by the mechanical action thereon of the vaporized refrigerant. To provide such traps the adjacent upper and lower respective horizontal layers of pipes are connected by loops 40 with the lower portion of each loop extending below the level of the respective lower layer pipes and upper portion of the loop extending above the level of the respective upper layer of pipes. That is, for example, taking the adjacent pipe layers A and B, the loop 40 connecting the same has a portion C extending below the level of lower pipe layer B and it also has a portion D extending above the level of the pipe layer A. In this manner traps are provided comprising depressed portions adjacent the exit ends of the various layers of the pipes and raised portions adjacent the entrance ends of the various layers of the pipes. The oil containing liquid lubricant will first collect in the lower layer and run into the trap E. The rush of refrigerant through the apparatus forces this up over the loop and it is prevented from running back by the raised trap F. It then readily flows along the second layer of pipe coils and is caught in the trap G, which not only tends to prevent any backward flow but also serves as a trap, like the trap E, to cause the rush of volatilized refrigerant to force the liquid up over the loop into the next pipe layer. This action is repeated through the remaining layers of pipe coils until finally any unvolatilized refrigerant with the liquid lubricant is carried over the upwardly extending trap H and into the chamber 17. By reason of the tangential induction of the pipe 32 into the chamber 17 and the spiral grooves 37 the mixture of volatilized refrigerant and liquid refrigerant and lubricant is given a whirling motion so as to be brought into intimate contact with the pipe coil 20, and heat absorbed from the relatively warm liquid refrigerant passing therethrough causes volatilization of further refrigerant from the oil. The volatilized refrigerant is drawn off at the upper end of the chamber through the pipe 33 by the suction of the compressor, while liquid lubricant laden refrigerant settles to the bottom of the chamber. Here, by reason of the relatively warm liquid refrigerant passing through the pipe 19, substantially all of the remaining liquid refrigerant is distilled from the lubricant and passes upward and off through pipe 33, leaving a layer of oil in the bottom of the chamber with very little, if any, of the refrigerant therein.

The height of liquid collected in the bottom of the chamber may be observed by a

gage glass 41. The lubricant so collected may be transferred back to the compressor by a pipe connection 42 through a valve 43 for regulating the flow. A layer of liquid lubricant should be retained in the bottom of the chamber to provide a seal to prevent refrigerant from escaping to the compressor through the pipe connection 42. Therefore the valve 43 is only opened to permit part of the collected lubricant to pass into the compressor. This may be done from time to time by hand by opening the valve when the liquid level appears near the top of the gage glass 41 and permitting the lubricant to run into the compressor until the liquid level is near the bottom of the gage glass when the valve should be closed.

I prefer, however, to accomplish this automatically and for this purpose I have shown the lower end of the chamber provided with a bulge at 44 in which is located a thermostat 45 adapted, when the temperature in the oil layer increases above a certain point, to close an electrical circuit 46, 47, 48 through a source of electric current 49 and an electro-magnetic device 50 which opens the valve 43 to permit the oil to run back to the crank case of the compressor. When the liquid level in the chamber drops to such a point that the liquid around the thermostat contains a substantial amount of refrigerant the temperature thereat will be lowered and the electrical circuit opened to close the valve. In order to insure that the lubricant will flow through the pipe 42 to the crank case of the compressor I connect the crank case chamber, by pipe 51 with the suction end of the compressor through a check valve 52 which equalizes the pressure at both ends but prevents any flow through the check valve to the crank case of the compressor. The compressor is also shown provided with the usual cross-over by-pass connections 53 and 54. The upper portion of the collecting chamber 17 and the pipes 21, 32 and 33 may be insulated with suitable heat insulating material as indicated in dotted lines.

In Fig. 3 I have illustrated a further modification for automatically regulating the flow of lubricant from the collecting chamber through the pipe 42 to the compressor crank case. As there shown a float 55 rests on the liquid in the chamber, which float is connected to a spindle 56 connected to one end of a lever 57 the other end of the lever being connected to a link 58 adapted to open and close the valve 43. When the rich liquid lubricant in the chamber rises to a predetermined height, the float, through spindle 56, lever 57 and link 58 causes the valve to open and permit the lubricant to flow into the crank case through the pipe 42. When the liquid drops below the predetermined level the float closes the valve.

While I have described my improvements in great detail and with respect to a preferred form thereof, I do not desire to be limited to such details or form since many changes and modifications may be made and the invention embodied in widely different forms without departing from the spirit and scope thereof in its broader aspects. Hence I desire to cover all forms and arrangements coming within the language or scope of any one or more of the appended claims.

What I claim as new and desire to secure by Letters Patent, is:

1. In the method of recovering lubricant from the refrigerant in a refrigerating system wherein the refrigerant is compressed and liquefied in one part of the system and is caused to vaporize in the refrigerating part of the system and the lubricant is soluble in the refrigerant, the step which consists in transferring heat from the compressed refrigerant to lubricant laden refrigerant leaving the refrigerating part of the system to distill the refrigerant from the lubricant.

2. In the method of recovering lubricant from the refrigerant in a refrigerating system wherein the refrigerant is compressed and liquefied in one part of the system and is caused to vaporize in the refrigerating part of the system in which it passes in a general upward direction through layers of pipes one above another in a locality to be cooled, and the lubricant is soluble in the refrigerant, the step which consists in causing the refrigerant vapor in said pipes to entrain and by mechanical action carry out of said pipes the mixture of refrigerant and lubricant after said mixture has been rendered rich in lubricant by the progressive vaporization of the refrigerant contents of the mixture in the several layers of pipes in the locality to be cooled.

3. In the method of recovering lubricant from the refrigerant in a refrigerating system, wherein the refrigerant is compressed and liquefied in one part of the system and is caused to vaporize in the refrigerating part of the system in which it passes upwardly through layers of pipes in a locality to be cooled, and the lubricant is soluble in the refrigerant, the steps which consist in causing the refrigerant vapor in said pipes to entrain and by mechanical action carry out of said pipes the liquid lubricant therein, and in transferring heat from the compressed refrigerant to the lubricant laden refrigerant leaving said pipes to distill and separate the refrigerant from the liquid lubricant.

4. In the method of recovering lubricant from the refrigerant in a refrigerating system wherein the refrigerant is compressed and liquefied in one part of the system and is caused to vaporize in the refrigerating part of the system in which it passes through pipes in a locality to be cooled, and the lubricant is soluble in the refrigerant, the step which consists in causing the refrigerant vapor in said

pipes to entrain and by mechanical action carry out of said pipes the mixture of refrigerant and lubricant after said mixture has been rendered rich in lubricant by the progressive vaporization of the refrigerant contents of the mixture in successive pipes in the refrigerating part of the system.

5. In the method of recovering lubricant from the refrigerant in a refrigerating system, wherein the refrigerant is compressed and liquefied in one part of the system and is caused to vaporize in the refrigerating part of the system in which it passes through pipes in a locality to be cooled, and the lubricant is soluble in the refrigerant, the steps which consist in causing the refrigerant vapor in said pipes to entrain and by mechanical action carry out of said pipes the liquid lubricant therein, and in transferring heat from the compressed refrigerant to the lubricant laden refrigerant leaving said pipes to distill and separate the refrigerant from the liquid lubricant.

6. A refrigerating system having in combination means for compressing and liquefying a refrigerant, a series of cooling pipes in which the liquid refrigerant is permitted to vaporize and pass in a general upward direction in the pipes to effect cooling, said pipes having traps therein to prevent liquid therein from running down counter to the movement of vaporized refrigerant in the pipes, whereby liquid lubricant in the pipes is forced upwardly through the pipes and out thereof by the vaporized refrigerant, and means connected between said cooling pipes and compressing means for collecting liquid leaving said pipes.

7. A refrigerant system having in combination means for compressing and liquefying a refrigerant, a series of substantially horizontal layers of cooling pipes in which the liquid refrigerant is permitted to vaporize and pass in a general upward direction in the pipes to effect cooling, said pipes having traps therein to prevent liquid therein from running down counter to the movement of vaporized refrigerant in the pipes, whereby liquid lubricant in the pipes is forced upwardly through the pipes and out thereof by the vaporized refrigerant, and means connected between said cooling pipes and compressing means for collecting liquid leaving said pipes, said traps comprising depressed portions in the pipes adjacent the exit ends of various layers of the pipes and raised portions adjacent the entrance ends of various layers of the pipes.

8. A refrigerating system having in combination means for compressing and liquefying a refrigerant, a series of cooling pipes in which the liquid refrigerant is permitted to vaporize and pass in a general upward direction in the pipes to effect cooling, said pipes having traps therein to prevent liquid therein from running down counter to the movement of vaporized refrigerant in the pipes, whereby liquid lubricant in the pipes is forced upwardly through the pipes and out thereof by the vaporized refrigerant, and means connected between said cooling pipes and compressing means for collecting liquid leaving said pipes, and means whereby liquid refrigerant is distilled from the lubricant in said collecting means.

9. A refrigerating system having in combination means for compressing and liquefying a refrigerant, cooling pipes in which the liquid refrigerant is permitted to vaporize to effect cooling, means connected between said cooling pipes and compressing means for collecting liquid leaving said pipes, and means for transferring heat from the compressed refrigerant to the liquid in said collecting means to distill refrigerant from the lubricant therein.

10. A refrigerating system having in combination means for compressing and liquefying a refrigerant, a series of substantially horizontal layers of cooling pipes in which the liquid refrigerant is permitted to vaporize and pass in a general upward direction in the pipes to effect cooling said pipes having traps therein to prevent liquid therein from running down counter to the movement of vaporized refrigerant in the pipes, whereby liquid lubricant in the pipes is forced upwardly through the pipes and out thereof by the vaporized refrigerant, and means connected between said cooling pipes and compressing means for collecting liquid leaving said pipes, said traps comprising loops in said pipe, said loops connecting adjacent upper and lower layers of pipes respectively with the lower portion of the loop extending below the level of the respective lower layer of pipes and the upper portion of the loop extending above the level of the respective upper layer of pipes.

11. A refrigerating system having in combination means for compressing and liquefying a refrigerant, a series of substantially horizontal layers of cooling pipes in which the liquid refrigerant is permitted to vaporize and pass in a general upward direction in the pipes to effect cooling, said pipes having traps therein to prevent liquid therein from running down counter to the movement of vaporized refrigerant in the pipes, whereby liquid lubricant in the pipes is forced upwardly through the pipes and out thereof by the vaporized refrigerant, means connected between said cooling pipes and compressing means for collecting liquid leaving said pipes, and means for transferring heat from the compressed refrigerant to the liquid in said collecting means to distill refrigerant from the lubricant therein.

12. A refrigerating system having in combination means for compressing and liquefy-

ing a refrigerant, a series of substantially horizontal layers of cooling pipes in which the liquid refrigerant is permitted to vaporize and pass in a general upward direction in the pipes to effect cooling, said pipes having traps therein to prevent liquid therein from running down counter to the movement of vaporized refrigerant in the pipes, whereby liquid lubricant in the pipes is forced upwardly through the pipes and out thereof by the vaporized refrigerant, means connected between said cooling pipes and compressing means for collecting liquid leaving said pipes, means for transferring heat from the compressed refrigerant to the liquid in said collecting means to distill refrigerant from the lubricant therein, said last mentioned means comprising a pipe in the collecting means through which the compressed refrigerant passes, and means whereby the vapor and liquid entering the collecting means is given a whirling motion about said pipe to effect more rapid transfer of heat.

13. A refrigerating system having in combination means for compressing and liquefying a refrigerant, a series of substantially horizontal layers of cooling pipes in which the liquid refrigerant is permitted to vaporize and pass in a general upward direction in the pipes to effect cooling, said pipes having traps therein to prevent liquid therein from running down counter to the movement of vaporized refrigerant in the pipes, whereby liquid lubricant in the pipes is forced upwardly through the pipes and out thereof by the vaporized refrigerant, means connected between said cooling pipes and compressing means for collecting liquid leaving said pipes, means for transferring heat from the compressed refrigerant to the liquid in said collecting means to distill refrigerant from the lubricant therein, and a connection for transferring lubricant, collected in the collecting means, to the compressing means.

14. A refrigerating system having in combination means for compressing and liquefying a refrigerant, a series of substantially horizontal layers of cooling pipes in which the liquid refrigerant is permitted to vaporize and pass in a general upward direction in the pipes to effect cooling, said pipes having traps therein to prevent liquid therein from running down counter to the movement of vaporized refrigerant in the pipes, whereby liquid lubricant in the pipes is forced upwardly through the pipes and out thereof by the vaporized refrigerant, means connected between said cooling pipes and compressing means for collecting liquid leaving said pipes, means for transferring heat from the compressed refrigerant to the liquid in said collecting means to distill refrigerant from the lubricant therein, a connection for transferring lubricant, collected in the collecting means, to the compressing means, and means automatically regulating the flow of lubricant through said connection.

15. A refrigerating system having in combination means for compressing and liquefying a refrigerant, a series of substantially horizontal layers of cooling pipes in which the liquid refrigerant is permitted to vaporize and pass in a general upward direction in the pipes to effect cooling, said pipes having traps therein to prevent liquid therein from running down counter to the movement of vaporized refrigerant in the pipes, whereby liquid lubricant in the pipes is forced upwardly through the pipes and out thereof by the vaporized refrigerant, and means connected between said cooling pipes and compressing means for collecting liquid leaving said pipes, said collecting means including an elongated vertical chamber, the lower portion of which is of reduced cross section and heating pipes therein through which the compressed refrigerant passes on its way to the cooling pipes to distill refrigerant from the lubricant in said collecting means, said heating pipes being located in the upper portion of said chamber and having a leg extending down into the reduced portion thereof.

16. A refrigerating system having in combination means for compressing and liquefying a refrigerant, a series of substantially horizontal layers of cooling pipes in which the liquid refrigerant is permitted to vaporize and pass in a general upward direction in the pipes to effect cooling, said pipes having traps therein to prevent liquid therein from running down counter to the movement of vaporized refrigerant in the pipes, whereby liquid lubricant in the pipes is forced upwardly through the pipes and out thereof by the vaporized refrigerant, means connected between said cooling pipes and compressing means for collecting liquid leaving said pipes, said collecting means comprising an elongated vertical chamber, the lower portion of which is of reduced cross section and heating pipes therein through which the compressed refrigerant passes on its way to the cooling pipes to distill refrigerant from the lubricant in said collecting means, said heating pipes being located in the upper portion of said chamber and having a leg extending down into the reduced portion thereof, and a connection for transferring lubricant collected in the collecting means to the compressing means, and means automatically regulating the flow of lubricant through said connection.

17. A refrigerating system having in combination means for compressing and liquefying a refrigerant, cooling means in which the liquefied refrigerant is permitted to vaporize to effect cooling, and means connected between said vaporizing means and compressing means for collecting liquid leaving said vaporizing means, said collecting means

comprising a chamber, means for transferring heat from the compressed refrigerant to the liquid in said chamber to distill refrigerant from lubricant therein, said last mentioned means including a pipe in the chamber through which the compressed refrigerant passes on its way to the vaporizing means, and means whereby the vapor and liquid entering the collecting means is given a whirling motion about said pipe to effect a more rapid transfer of heat.

18. A refrigerating system having in combination means for compressing and liquefying a refrigerant, cooling means in which the liquefied refrigerant is permitted to vaporize to effect cooling, and means connected between said vaporizing means and compressing means for collecting liquid leaving said vaporizing means, said collecting means comprising a chamber and means for transferring heat from the compressed refrigerant to the liquid in said chamber to distill refrigerant from lubricant therein, and a connection for transferring lubricant collected in said collecting means to the compressing means.

19. A refrigerating system having in combination means for compressing and liquefying a refrigerant, cooling means in which the liquefied refrigerant is permitted to vaporize to effect cooling, and means connected between said vaporizing means and compressing means for collecting liquid leaving said vaporizing means, said collecting means comprising a chamber and means for transferring heat from the compressed refrigerant to the liquid in said chamber to distill refrigerant from lubricant therein, a connection for transferring lubricant collected in said collecting means to the compressing means, and means automatically regulating the flow of lubricant through said connection.

20. A refrigerating system having in combination means for compressing and liquefying a refrigerant, cooling means in which the liquefied refrigerant is permitted to vaporize to effect cooling, and means connected between said vaporizing means and means for collecting liquid leaving said vaporizing means, said collecting means comprising an elongated vertical chamber, the lower portion of which is of reduced cross-section and heating pipes therein through which the compressed refrigerant passes on its way to the cooling pipes to distill refrigerant from the lubricant in said collecting means, said heating pipes being located in the upper portion of said chamber and having a leg extending down into the reduced portion thereof.

21. A refrigerating system having in combination means for compressing and liquefying a refrigerant, cooling means in which the liquefied refrigerant is permitted to vaporize to effect cooling, and means connected between said vaporizing means and compressing means for collecting liquid leaving said vaporizing means, said collecting means comprising an elongated vertical chamber, the lower portion of which is of reduced cross-section and heating pipes therein through which the compressed refrigerant passes on its way to the cooling pipes to distill refrigerant from the lubricant in said collecting means, said heating pipes being located in the upper portion of said chamber and having a leg extending down into the reduced portion thereof, and a connection for transferring lubricant collected in the collecting means to the compressing means.

In testimony whereof I have signed my name to this specification.

THOMAS M. GUNN.