This invention relates to a refrigeration system and particularly to mechanism for removing oil and non-condensible gases from the refrigerant.

Objects of the invention are to provide oil and gas removal mechanism wherein:

(1) The design of the mechanism is such as to eliminate certain oil separators, separator heaters, separator heater thermostats, suction and discharge valves, driving motors, solenoid valves, motor starters, relays switches and pilot lights heretofore employed, and

(2) The mechanism is relatively compact, requires minimum maintenance, employs a minimum of wiring at the plant and in the field, eliminates acid generation in the system, and makes possible the attainment of a hermetically sealed centrifugal compressor unit.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

In the drawings:

Fig. 1 is a schematic view of a refrigerating system having the invention incorporated therein.

Fig. 2 is a sectional view illustrating an alternate vaporizing mechanism which may be employed in the Fig. 1 system.

Before explaining the present invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

In the drawings there is shown a refrigerating system including a centrifugal compressor 10, which may be a multiple stage unit as shown in U.S. Patent No. 2,759,662 or a single stage unit. The construction of the unit is such as to deliver freon or other refrigerant vapor through line 12 to a condenser 14.

Condenser 14 comprises a shell 16 containing two circular tube sheets 18 and 20 for supporting heat exchange tubes 21. A partition 22 extends from sheet 18 to the adjacent end wall of the shell. In operation, cooling water from inlet pipe 24 passes through the upper ones of heat exchange tubes 21 in the arrow 26 direction and then flows through the lower ones of the heat exchange tubes in the arrow 28 direction so as to be exhausted through outlet pipe 30. As the water flows through the heat exchange tubes it liquifies the refrigerant vapor passing over the tubes from line 12. The liquified refrigerant settles in the bottom of shell 16, from where it passes through line 32 and a liquid seal (not shown) to an evaporator 33.

Evaporator 33 comprises a cylindrical shell 35 containing tube sheets 36 and 37 for supporting finned heat exchange tubes 38. A partition 39 extends from sheet 36 to the adjacent end wall of the shell. In operation, heat exchange fluid from inlet pipe 40 is circulated through tubes 38 and out through outlet pipe 41 so as to vaporize the refrigerant from pipe 32. The vaporized refrigerant passes over tubes 38 and through an eliminator 42 and into a line 43 leading to the inlet for compressor 10.

Condenser shell 16 connects with a line 45, which serves to conduct a non-condensible gas, oil and refrigerant vapor mixture from the upper portion of the condenser shell where it tends to collect during operation of the system. Line 45 leads to a positive displacement vacuum pump 46 located within an oil tank 47. Pump 46 is driven by a motor 79, which also drives lubricant pump 78. The outlet for pump 46 is connected to a line 48, which leads to a spray pipe 50 located within a purge drum 51.

In operation, pump 46 acts to pump the non-condensible gas, oil and refrigerant vapor mixture from shell 16 into spray pipe 50. The mixture is sprayed over a coil structure 53 in which is circulated cooling water, the arrangement being such that the refrigerant is liquified so as to collect at the bottom of the purge drum. The non-condensibles are vented from the purge drum to the atmosphere through a conventional relief valve 55.

The purge drum is provided with a central partition 57, which has the function of requiring the vapor from pipe 58 to circulate around coil structure 53 without traveling immediately to the right end of the drum. This arrangement insures a good heat exchange condition which contributes to complete liquification of the condensibles and separation of the non-condensibles.

During operation, moisture and the lighter condensibles are deposited as a liquid layer 60 on the upper surface 61 of the liquified refrigerant. The lighter materials in layer 60 have a lesser specific gravity than the liquified refrigerant; consequently the liquid surface 62 to the left of partition 57 is slightly above the liquid surface 63 to the right of partition 57. A valve drain tube 64 extends into the purge drum and terminates at a point above the level of surface 63 so as to draw off the layer 60 liquid.

The liquid level 63 is maintained constant by means of a valve 65, which controls the escape of liquid from drum 51 into a line 66. Valve 65 is operated by a float 67 in such manner that as surface 63 tends to rise, float 67 moves valve 65 to an open position, and as surface 63 tends to fall float 67 moves valve 65 to a closed position. Partition 57 maintains a stable gas pressure in the space above float 67 so as to permit accurate operation of valve 65.

Line 66 leads into tank 47 to connection with a heat exchange tube 70. A lubricant line 71 extends from the bearings of compressor 10, into tank 47, and axially through tube 70 so as to discharge oil into the tank to a normal level 90.

In a typical installation the oil in line 71 is at a temperature of about 160°F, which is sufficient to vaporize the refrigerant vapor in tube 70. The oil associated with the refrigerant remains in a liquid condition and fills tube 70 to a level above line 71 so as to promote heat transfer. Some of the oil in tube 70 becomes entrained with the vaporized refrigerant flowing out through discharge pipe 72. The velocity of the oil after it leaves pipe 72 is considerably reduced so that the entrained oil separates out in droplets, which gravitate into the main body of oil 74. The refrigerant vapor in the space above oil body 74 is discharged from tank 47 into a line 76, which connects with the main refrigerant line 43 leading to compressor 10. If desired line 76 may connect to the evaporator or other low pressure area in the system.

The flow of lubricant in the system is effected by an oil-immersed pump 78, which is driven by motor 79. Pump
3 78 connects with a line 80 which leads to the compressor 10 for supplying the compressor bearings with lubricant. Line 71 takes the lubricant from the compressor bearings to tank 47. During operation of the system some of the lubricant in the bearings becomes entrained with the refrigerant passing through the compressor. However this entrained lubricant is subsequently removed in tube 70 and tank 47; hence the lubricant is prevented from entering the refrigeration system.

Fig. 2 illustrates a construction which may be used in the Fig. 1 system in place of heat exchange tube 70. In the Fig. 2 arrangement line 66 discharges into tank 47 at a point directly above a small receptacle 82 which receives hot lubricant from pipe 71. As the refrigerant oil mixture strikes the hot lubricant in receptacle 82 the refrigerant is vaporized. The lubricant spills out of the receptacle into tank 47 to maintain oil level 90. If desired a small electric heater 83 may be employed to maintain vaporizing conditions above the receptacle.

The illustrated mechanisms for removing the oil and non-condensibles are comparatively inexpensive to manufacture. At the same time the mechanisms are efficient in their operation so as to prevent any possibility of damage to the refrigerating system. Additionally the mechanisms require a minimum of maintenance and parts replacement.

1. The combination comprising a refrigerating system including a refrigerant compressor, condenser and evaporator; a lubricant circulating circuit for the compressor bearings; means for diverting non-condensibles and vaporous refrigerant from the system; means operative on the diverted refrigerant and non-condensibles to liquify the refrigerant and separate off the non-condensibles; and means for returning the diverted liquified refrigerant back to the refrigerating system; said lubricant circuit including means for positioning high temperature lubricant in heat transfer relationship with the diverted liquid mixture to thereby vaporize said refrigerant before its return to the system.

2. The combination of claim 1 wherein the lubricant circuit comprises a lubricant supply tank; and the means for returning the liquified refrigerant includes a refrigerant liquid line discharging into said supply tank so that the refrigerant is vaporized by the lubricant.

3. The combination of claim 1 wherein the lubricant circuit comprises a lubricant tank and a lubricant pump therein; and wherein the refrigerant diverting means comprises a refrigerant pump physically located within the lubricant tank.

4. The combination of claim 3 and further comprising a single power means for driving the lubricant pump and refrigerant pump.

5. In a refrigeration system the combination comprising a refrigerant condenser; a refrigerant centrifugal compressor connected directly to the condenser, a lubrication system including a lubricant tank for supplying lubricant to the compressor bearings; a purge chamber for removing non-condensibles from the refrigerant; a first line from the condenser to the purge chamber; cooler means in the purge chamber for liquifying the refrigerant discharged from said line; a centrifugal pump in the first line to direct non-condensibles from the condenser to the purge chamber, a vent means connected to the purge chamber for removing the non-condensibles from association with the refrigerant; a second line from the purge chamber to the lubricant tank; a heat exchange unit in the lubricant tank connected with the second line from the refrigerant centrifugal compressor to the heat exchange unit; whereby hot lubricant from the compressor is enabled to flow into the heat exchange unit so as to vaporize refrigerant before its introduction into the compressor, and a line associated with the heat exchange unit in the lubricant tank to direct vaporized refrigerant to the centrifugal compressor.

6. In a refrigeration system the combination comprising a refrigerant condenser; a refrigerant centrifugal compressor connected directly to the refrigerant condenser, a lubrication system including a lubricant tank for supplying lubricant to the compressor bearings; a purge chamber for removing non-condensibles from the refrigerant; a first line from the condenser to the purge chamber; cooler means in the purge chamber for liquifying the refrigerant discharged from said line; a second line from the condenser to the purge chamber for removing the non-condensibles from association with the refrigerant; a second line from the purge chamber to the lubricant tank; a receptacle within the lubricant tank positioned below the point of discharge of the second line; a third line from the refrigerant compressor to the lubricant tank; and a line associated with the lubricant tank to direct vaporized refrigerant to the centrifugal compressor.
line; a third lubricant line from the refrigerant compressor extending centrally through the heat exchange tube and discharging into the lubricant tank interior whereby hot lubricant from the compressor is enabled to flow into the heat exchange unit so as to vaporize the refrigerant in the heat exchange tube, and a line to direct vaporized refrigerant to the centrifugal compressor.

10. In a refrigeration system the combination comprising a refrigerant condenser; a centrifugal refrigerant compressor connected to the condenser, a lubrication system including a lubricant tank for supplying lubricant to the compressor bearings; a purge chamber for removing non-condensibles from the refrigerant; a first line from the condenser to the purge chamber; cooler means in the purge chamber for liquefying the refrigerant discharged from said line; a vent means connected to the purge chamber for removing the non-condensibles from association with the refrigerant; a second line from the purge chamber to the lubricant tank; a centrifugal condensable and non-condensible gas pump located within the lubricant tank and connected into the first line; a lubricant pump within the lubricant tank; a third line from said lubricant pump to the compressor bearings; a motor having a double ended drive shaft; said motor being positioned between the two pumps with the ends of the shaft drivingly connected to the pumps; means for vaporizing the liquefied refrigerant as it enters the tank from the second line, and a line to conduct vaporized refrigerant to the centrifugal compressor.

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