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OIL SEPARATION ARRANGEMENT IN REFRIGERATION SYSTEMS

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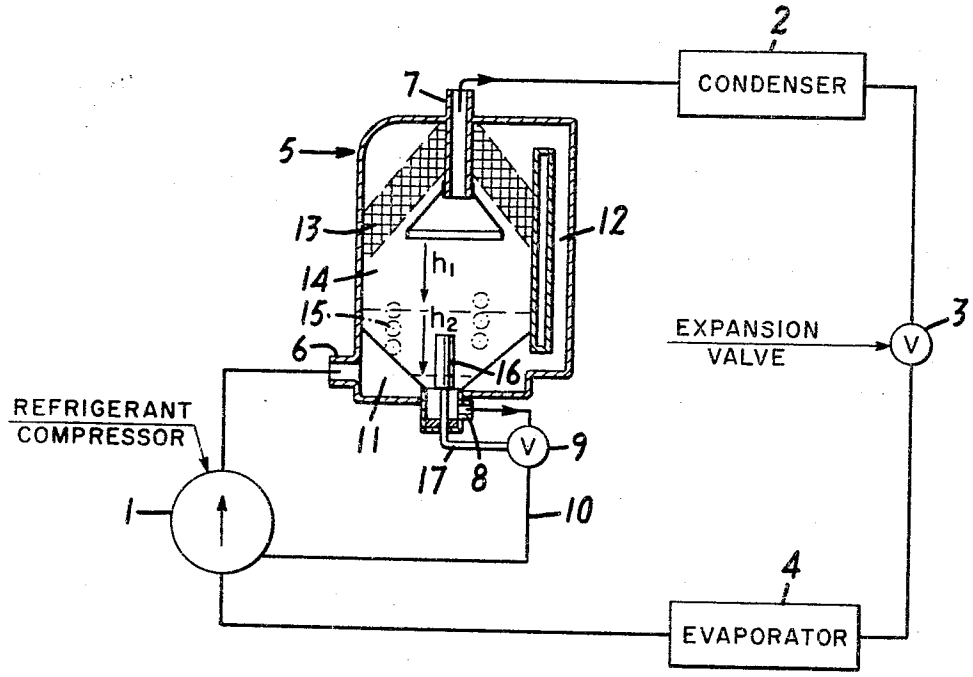
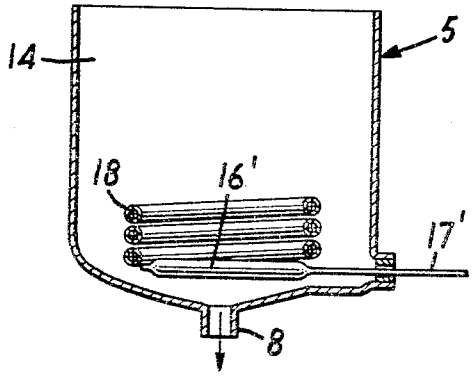


FIG. 1

FIG. 2



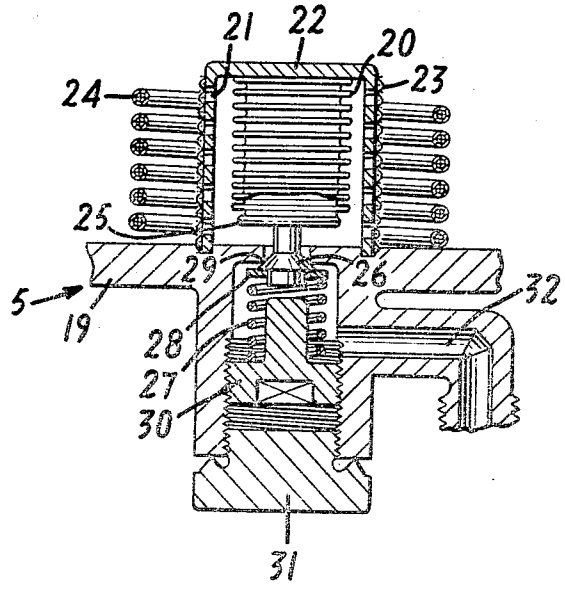


FIG. 3

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OIL SEPARATION ARRANGEMENT IN REFRIGERATION SYSTEMS

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ABSTRACT OF THE DISCLOSURE

Arrangement for refrigerator compressors for separating oil from the refrigerant having a separation chamber capable of separating oil from a refrigerant. The oil collected in the chamber is discharged through a controlled outlet valve controlled thermostatically by a sensing element in the chamber exposed to the oil separated from the oil-refrigerant mixture and the degree of surface exposure of the sensing element depends upon the oil level in the separation chamber. The thermostatic valve is closed so long as the oil-refrigerant mixture does not exceed the refrigerant's evaporation temperature and opens when all the refrigerant has evaporated or been removed from the oil-refrigerant mixture delivered to the separation chamber i.e. if the temperature of the sensing element is in excess of the evaporation temperature of the refrigerant.

The present invention relates to an arrangement to separate oil, for example leakage oil, from a refrigeration medium in a refrigeration system, and more particularly to an arrangement utilizing thermostatically controlled tap-off valves connected to return separated oil to the sump of the compressor.

It is customary to provide oil separators in the pressure line between the compressor and the condenser, or heat radiator of refrigeration systems. Oil particles mixed with the gaseous refrigeration medium have to be separated. Frequently some refrigeration medium is dissolved in the oil and heating arrangements have been proposed in order to remove the dissolved refrigeration medium from the oil.

In a form of prior constructions, a float is used in combination with an oil tap-off or bleeder valve which permits the drainage of oil when the level of oil within the sump exceeds a certain height. This has the disadvantage that oil is tapped off, even if it still contains dissolved refrigeration medium, thus interfering with the purity of the oil, while at the same time reducing the refrigeration charge in the refrigeration system. In order to avoid this disadvantage, it has been proposed to provide an additional thermostatic system, operative in dependence on the temperature of the oil separator. Since, however, an accumulation of oil within the separator must still be drained, the thermostatic system can only delay but not totally avoid drainage of refrigeration medium together with oil. If the float valve is placed in series with a thermostatically controlled valve, a coincidence of events has to occur before drainage is permitted—temperature of the oil separator above a given point, as well as oil level above a certain height in the sump. This arrangement requires a pair of valves and further, that the second valve in the chain must be provided with a pressure equalization device at the high pressure side, connected back to the oil separator. Such a pressure equalization device, which includes a pressure equalization line, interferes with the proper functioning of such an arrangement. If the refrigeration system operates intermittently, the second-connected

valve is frequently, or possibly even constantly, at a temperature which is less than that of the condenser; yet, the temperature of the condenser is variable, being dependent on the filling thereof obtained from the compressor. From time to time, a substantial quantity of hot, compressed refrigerating medium is led to the condenser. This temperature difference causes condensation back towards the second-connected valve, occurring at the pressure equalization line between the valve and oil separator as well as in the line between condenser and oil separator. Thus, the second-connected valve will collect pure refrigeration medium, which, when this valve opens, is drained together with the oil, again leading refrigeration medium from the system in reducing the refrigeration charge, as well as diluting and contaminating the oil in the compressor sump.

It is an object of the present invention to provide a refrigeration system having an oil tap, or oil bleeder valve, which is arranged and constructed to lead only pure oil from the oil separator.

Briefly, in accordance with the present invention, a separating chamber is provided to collect heated, compressed refrigeration medium, having oil particles therein. The separating chamber acts as a collecting chamber and the oil will eventually collect at the bottom thereof. A thermostatically controlled outlet valve is arranged in the bottom of the chamber, connected to an oil bleeder, or oil outlet line. The thermostatically controlled valve is so placed and located within the chamber, and so arranged, that its surface is exposed to the oil separated from the oil-refrigeration medium mixture coming in through the inlet and that the degree of surface exposure to the oil depends on the level of the oil within the separating chamber itself.

The single oil outlet valve, located to have its surface exposed to oil as above described, then functions in such a manner that the thermostatic valve is closed so long as the refrigeration medium-oil mixture does not exceed the evaporation temperature of the refrigeration medium itself. Thus, the valve can open only after all, or practically all of the refrigeration medium has been evaporated out of the mixture. Heating elements, as previously proposed in connection with other structures, can further be used in order to increase this temperature. The temperature surrounding the thermostatic valve thus acts as a measure of the degree of refrigeration medium quantity in the oil, and is used to open the valve when this quantity sinks below an acceptable level. Due to the location of the valve as above referred to, it will close automatically when the temperature of the temperature sensing element falls below a set value. This temperature decrease occurs when, after a substantial part of the surface of the thermostatically controlled valve is in contact only with the vapor of the refrigeration medium and no longer in contact with the oil. Since the heat conductivity of the vapor is much less than that of the oil itself, the temperature of any heating elements within the separating chamber is not transferred to the same extent to the temperature sensitive valve, as would occur when oil is present, and thus retain the valve in an open position. The entire cycle is further assisted by the general cooling of the refrigeration medium in the system by the usual heat losses due to radiation during an intermittent shut-down period of the compressor.

The present invention thus provides a system in which practically pure oil must be present before the valve will open, due to the interaction of heat transfer and location of the thermostatically controlled valve; and further that the drain of pure oil stops without substantial delay as soon as the valve is no longer immersed in hot oil.

The supply of external heat can be obtained electrically, or the compressed, super-heated refrigeration means can act as a heat source as well. In order to save space and for ease of construction, the thermostatically controlled valve can be arranged directly within the oil sump. It then functions simultaneously as a sensing arrangement as well as the operating element for the oil. Utilizing an inverted cup, with perforated sidewalls, provides a simple, and advantageous construction, enabling the working parts of the valve to be directly placed within the chamber. A fine mesh screen, and a heating coil, if necessary, are preferably arranged to surround the cup to filter the oil and to provide for proper heat transfer.

The structure, organization and operation of the invention will now be described more specifically in the following detailed description with reference to the accompanying drawings, in which:

FIG. 1 illustrates, in schematic form, the refrigeration system utilizing the oil separating arrangement according to the present invention;

FIG. 2 is a partial view of oil separator, in schematic form, and

FIG. 3 is a partial vertical cross-sectional view of an oil drainage valve in accordance with the present invention.

Referring now to the drawings, and more particularly to FIG. 1, where parts of the refrigeration system well-known in the art and not forming a specific feature of the present invention, are shown in schematic form: A compressor **1** is connected to a condenser **2**, then to an expansion valve **3** and an evaporator **4** back to the compressor **1**, in order to form a closed refrigeration system. An oil separator **5** is arranged between the compressor **1** and the condenser **2**. Oil separator **5** has an inlet connection **6** to receive the refrigeration medium, which has some oil enclosed therein; refrigeration gas outlet **7** and oil outlet **8**. Oil outlet **8** is connected over a thermostatically controlled valve **9** by means of line **10** back to the oil sump of compressor **1**.

The super-heated, compressed refrigeration medium, which has oil particles carried therein, is admitted through inlet **6** into a heating chamber **11**, then conducted over a line **12**, which may be formed by a baffle within separator **5**, to internal baffles **13**, which may include a filter, into the oil separation chamber **14** itself. The refrigeration medium may also be led through heating coils **15** after having been admitted through chamber **11**, and in advance of being conducted through line **12**, filter **13** into chamber **14**. Since this is an alternative arrangement, heating coils **15** are shown in dashed form.

The lower portion of chamber **14** is provided with a thermostatic sensing element **16**, connected to a capillary line **17** to control opening and closing of valve **9**. The thermostatically operated valve **9** is so arranged that when the temperature sensed by sensing element **16** is above the evaporating temperature of the refrigeration medium, the valve opens; and when it is below the evaporation temperature, the valve closes.

Operation.—Let it be assumed that the liquid level within the oil separator **5** is at h_1. This liquid level is heated by the evaporation medium-oil mixture within heating chamber **11** and, if used, by the coils **15** through which the medium passes. The temperature of the oil at this level will be the evaporation temperature of the refrigeration medium, that is the temperature attained until all of the refrigeration medium has been evaporated. The oil temperature can rise only after all the evaporation medium has been evaporated. This temperature is sensed by sensing device **16**, opening valve **9**. Thus, the oil which is now practically pure, is led over line **10** back into the oil sump of the compressor. As soon as the surface of sensing element **16**, however, is no longer wetted or covered to the same extent by liquid, the transfer of heat from heating room **11** to the sensing element **16** can no longer occur to the same extent; the temperature within sensing element **16** will fall, and valve **9** will again close. This may occur, for example, when the liquid level has been reduced to the height h_2. If it is desired that bleeding valve **9** closes with but little delay, feeler **16** can be connected to the outside through a radiating baffle, rather than only through the capillary tubes **17**, so that the temperature of sensing element **16** will drop quickly when heat is no longer supplied thereto. Thus, the bleeding valve **9** will remain closed until the oil separator has been filled with so much liquid that the sensing element **16** is again covered, its temperature rises, and the cycle starts all over again.

FIG. 2 illustrates a sensing element **16'**, having a capillary tube **17'**. It is arranged horizontally within the separator **5**. An electrical heating coil **18** is provided to supply heat to the liquid within separator **5**. Parts similar to those within the separator shown in FIG. 1 have been omitted from FIG. 2. Arranging sensing element **16'** horizontally requires only small differences in liquid level within separator **5** in order to decrease the temperature of the sensing element **16'** to cause closing of valve **9**. Providing an electrical heating arrangement has the advantage that it is effective even when the compressor **1** of the system is not operating, so that oil can be separated from the liquid level within the separator **5** even during shutdown of the compressor.

FIG. 3 illustrates a suitable construction of a combination sensing element and bleeding valve. The bottom level of evaporator housing **5**, indicated at **19**, has a valve seat **29** formed thereon, cooperating with a valve element **26**, which is pressed against the valve seat by means of a spring **27** bearing against a holding washer **28**. The spring pressure of spring **27** is adjustable, by changing the height of an adjustment plug **30**, screwed into a boss formed in the bottom **19** of separator **5**. A covering screw **31** is provided to prevent inadvertent changing of the pressure setting.

A cup-shaped cover **22**, having perforations **21** formed in its sides, holds the sensing element **20** which simultaneously functions as the control element for the valve. Sensing element **20** may, for example, be a bellows secured to a plate **25** which, in turn, is operative to press against the spring and open valve element **26** when the temperature within the bellows rises above a predetermined level. The mesh screen **23** surrounds the cup **22**; electrical heating coils, **24**, or coils conducting compressed, super-heated refrigeration fluid and located similar to heating coils **24** preferably surround the entire assembly. The oil is taken off through on oil outlet duct **32**, if drainage of oil admitted through perforations **21** and permitted by opening of valve element **26** from valve seat **29** occurs. Outlet **32** is again connected to line **10** (FIG. 1). The temperature sensitivity can be adjusted by varying the pressure of spring **27** counteracting the expansion of bellows **20**.

Thermostatically controlled valves as above described can be adjusted easily, so that oil can be bled out of the system already in small quantities, for example just at the beginning of a period of compression after shutdown. This has the advantage that little oil has to be drained when the compressor is shut down, so that condensation of refrigeration medium, back from the condenser into the oil separator during such shutdown, is negligible. Electrically heating the region surrounding the thermostatically controlled valve may cause rapid evaporation of any such refrigeration medium which has condensed and drained back, so that no condensate will actually form.

I claim:

1. Refrigeration system having a compressor to compress a gaseous refrigeration medium, a condenser, means interconnecting said compressor and condenser and means to separate leakage oil from the gaseous medium connected to said interconnection means, said separating means comprising

means forming a separating chamber to collect heated, compressed refrigeration medium and oil particles; inlet means for said refrigeration-oil mixture; refrigeration medium outlet means; and oil outlet means; and a thermostatically controlled outlet valve associated with said chamber controlling flow through said oil outlet means, said valve having a sensing means located at the bottom of said chamber and with respect to said refrigeration inlet and refrigeration outlet means to have its surface area exposed to the oil separated from said mixture, the relative degree of exposure of surface area to oil with respect to the surface area exposed to the oil-refrigeration medium mixture depending upon the level of said oil within said settling chamber; said valve being set to permit flow of oil through said oil outlet means if the temperature of all said surface area is in excess of the evaporation temperature of said refrigeration medium, said thermostatically controlled outlet valve including an inverted, perforated cup located in the bottom of said chamber, a valve seat arranged at the bottom of said chamber and communicating with said oil outlet means; a valve body seating on said

valve seat; said temperature sensitive element being located within said perforated cup and directly operatively connected to said valve body to operate said valve body and open said valve when the temperature acting on a predetermined portion of the surface area of said sensing element exceeds the evaporation temperature of said refrigeration medium; a mesh screen surrounding said inverted, perforated cup; and heating means surrounding said mesh screen.

2. System as claimed in claim **1**, wherein said heating means comprises an electrical heating coil.

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