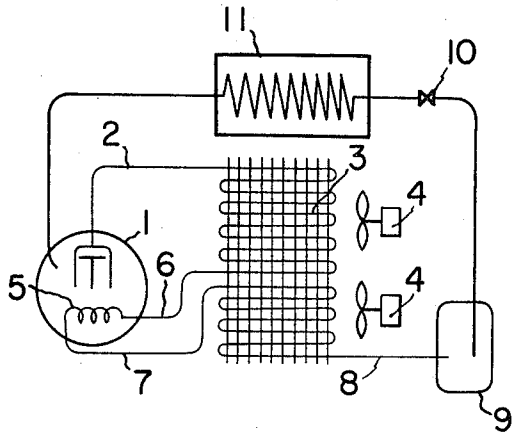
May 5, 1970 CHIKARA SHIMAZAWA 3,509,731

OIL COOLING ARRANGEMENT IN REFRIGERATION SYSTEM

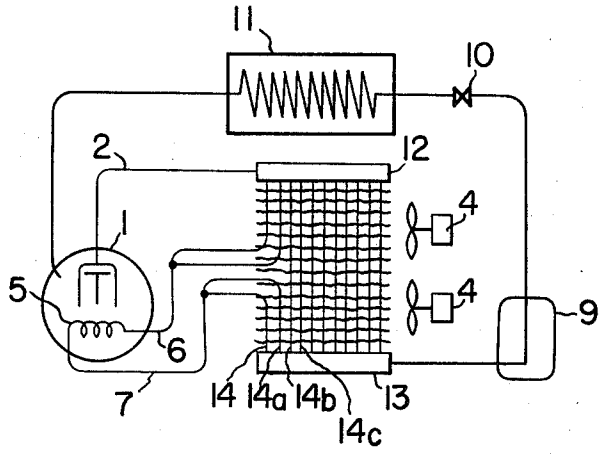
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FIG. 1



PRIOR ART

FIG. 2



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OIL COOLING ARRANGEMENT IN REFRIGERATION SYSTEM

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ABSTRACT OF THE DISCLOSURE

Some of the cooling tubes of an air-cooled refrigerant condenser of the multiple, parallel flow path type in a refrigerating system having a refrigerant compressor are connected of their intermediate parts in series with a heat exchanger for cooling the lubricating oil of the compressor. This organization affords low flow resistance in the condenser.

BACKGROUND OF THE INVENTION

This invention relates generally to refrigerating apparatuses in which air-cooled type condensers are used. More particularly, the invention concerns cooling means whereby overheating of the compressor in such a refrigerating apparatus is prevented.

Compressors used in recent refrigeration apparatuses, in general, are required to be of small size, light weight, and high performance. Accordingly, there is a trend toward changing from four-pole to two-pole motors for driving the compressors to double the rotational speed and to reduce the piston displacement per cylinder with the aim of reducing the size of the compressor unit.

For this reason, the temperature of the compressor during the operation of the refrigerating apparatus rises excessively since the heat generation rate increases in comparison with that in a four-pole motor as used in the past, and, at the same time, the heat radiating area is small because of the reduction in the size of the entire structure. Thus, depending on the conditions of use, this overheating becomes a cause of malfunctioning or failure.

Particularly in a low-temperature refrigerating apparatus for obtaining temperatures below minus 40 degrees C., the temperature of the compressor rises substantially because of the low flowrate of the return gas of the refrigerant, large compression ratio of the refrigerant, and other causes. Consequently, the compressor efficiency drops, and, moreover, the lubricant within the compressor deteriorates and loses its lubricating capacity. As an ultimate result, damage such as seizure of bearing parts, damage to valves due to excessive temperature, and heat damage to the motor occurs whereby the compressor can no longer operate.

Accordingly, a common expedient heretofore resorted to has been to cool the lubricant of the compressor by means of a heat exchanger connected in series with the refrigerant path through the condenser at an intermediate point thereof as described more fully hereinafter. While this expedient as applied to conventional refrigeration systems is effective for small-capacity refrigerating apparatuses, it is unsatisfactory for apparatuses of larger capacity because of difficulties caused principally by high circuit resistance to refrigerant flow.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a refrigerating apparatus in which the above described difficulties are overcome by decreasing the refrigeration circuit flow resistance and causing condensed refrigerant liquid constituting a coolant for ample heat exchange to circulate through a cooling heat exchanger for cooling the lubricant within the compressor of the circuit.

According to the present invention, briefly summarized, there is provided in a refrigerating apparatus of the above stated character, the combination therewith of a condenser of multiple, parallel flow path type having a plurality of cooling tubes and a heat exchanger connected in series with at least one of the cooling tubes at an intermediate point thereof and thereby causing a portion of the condensed refrigerant to circulate through the heat exchanger to cool oil for lubricating the compressor of the apparatus.

The nature, principle, and details of the invention will be more clearly apparent from the following detailed description with respect to an unsatisfactory feature of an apparatus of a known organization and with respect to a preferred embodiment of the invention when read in conjunction with the accompanying drawing, in which like parts are designated by like reference numerals.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing:

FIG. 1 is a schematic diagram showing the flow circuit of an example of a known refrigeration system of air-cooled condenser type; and

FIG. 2 is a similar schematic diagram showing the flow circuit of an example of a refrigeration system embodying the invention.

DETAILED DESCRIPTION

As conducive to a full understanding of the nature and utility of the present invention, a brief description of a known refrigeration system and a difficulty accompanying the same will first be presented.

Referring to FIG. 1, the refrigeration system comprises, essentially, a compressor **1**, a condenser **3** of single flow path, multiple-pass type cooled by fans **4**, a refrigerant liquid sump tank **9**, an expansion valve **10**, and an evaporator **11** connected as indicated. The compressor is provided with a built-in heat exchanger (hereinafter referred to as an oil cooler) **5** connected in series with the tubing of the condenser **3** at an intermediate point thereof.

In the operation of this system, refrigerant vapor discharged from compressor **1** passes through a delivery pipe **2** to the condenser **3** where it is cooled by fans **4** to be liquefied. All of the refrigerant thus liquefied flows through a pipe **6** and oil cooler **5** where it undergoes heat exchange with overheated lubricating oil, that is, receives heat from the oil, and vaporises. The resulting refrigerant vapor flows through a pipe **7** to return to condenser **3** where it is again cooled by fans **4** and is fully condensed into a liquid, which is sent through a pipe **8** to liquid sump tank **9** and then passes through expansion valve **10** to enter evaporator **11**. In evaporator **11**, the refrigerant liquid absorbs heat from the outside (i.e., the medium being refrigerated) and vaporizes, the resulting vapor then returning to compressor **1**.

In this known system, the tubing of the condenser **3** and the oil cooler **5** are connected in series as described above. While this arrangement does not present a problem in apparatuses of small size and small capacity since the condenser circuit itself does not have a very high resistance, when this arrangement is applied to an apparatus of large capacity exceeding 1 kw., the condenser circuit presents an extremely high resistance to refrigerant flow because of its long length. This high resistance gives rise to undesirable results such as high compressor delivery pressure whereby the performance of the apparatus drops, which results are extremely disadvantageous for a refrigerating apparatus.

In one example of preferred embodiment of the invention as illustrated in FIG. 2, the condenser is of multi-

ple-flow-path type comprising an inlet header **12**, an outlet header **13**, and a plurality of branch cooling tubes **14**, **14***a*, **14***b*, etc., connected parallelly between the headers **12** and **13**. The inlet header **12** operates in the manner of an inlet manifold to receive refrigerant gas delivered by the compressor **1** through a delivery pipe **2** and to distribute this gas uniformly to all cooling tubes **14**, **14***a*, etc., which are cooled by fans **4**. Accordingly, the refrigerant gas condenses in these tubes, and the resulting fully condensed liquid is collected in the outlet header **13**.

Some of the cooling tubes (for example, tubes **14** and **14***a* in the example illustrated in FIG. 2) are connected in series at an intermediate part thereof to an oil cooler **5** within the compressor **1** through pipes **6** and **7**. The condensed refrigerant liquid thus conducted into the oil cooler **5** absorbs heat from overheated lubricating oil within the compressor **1** and vaporizes, and the resulting vapor returns through pipes **7** to the condenser to be cooled and condensed again. The fully condensed refrigerant liquid then enters the outlet header **13** to flow confluently out of the condenser together with condensed refrigerant which has passed through the cooling tubes other than tubes **14** and **14***a*.

From outlet header **13**, the refrigerant flows through liquid sump **9**, expansion valve **10**, and evaporator **11** to return to compressor **1** in the same manner as described hereinbefore with respect to the known system illustrated in FIG. 1.

From the foregoing description, it will be apparent that the condenser of the construction for use in the system according to the invention does not have a single flow path as in a system of known type but is of multiple, parallel flow path type comprising inlet and outlet headers and branch tubes connected therebetween. Accordingly, the length of the refrigerant flow path in the circuit from delivery from the compressor through condensation and liquefaction is shorter than that of a system in which a condenser of single-flow-path, multiple-pass type is employed, whereby the flow resistance within the shorter flow path is much lower. Therefore, there is no possibility of increased compressor delivery pressure or adverse effect on the performance of the apparatus.

Furthermore, since condensed refrigerant liquid is conducted through the oil cooler of the compressor from only some of the branch cooling tubes, the flow resistance of the entire condenser is negligibly low. Accordingly, overheating of the compressor is prevented without an appreciable loss in performance due to the installation of the oil cooler.

I claim:

1. In a refrigerating system having a refrigerant compressor, a heat exchanger having a refrigerant path and operating to cool lubricating oil of said compressor, and a condensed refrigerant path, the combination therewith of a refrigerant condenser of air-cooled type having multiple, parallel flow paths and comprising inlet and outlet headers and a plurality of tubes for cooling refrigerant passed therethrough connected parallelly between said headers, said condenser being connected between said compressor and said condensed refrigerant path, at least one of said tubes being connected in series at an intermediate point thereof with said refrigerant path of said heat exchanger, whereby a portion of the refrigerant passing through the condenser is diverted to circulate through and evaporate in the heat exchanger thereby to prevent overheating of the compressor.

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