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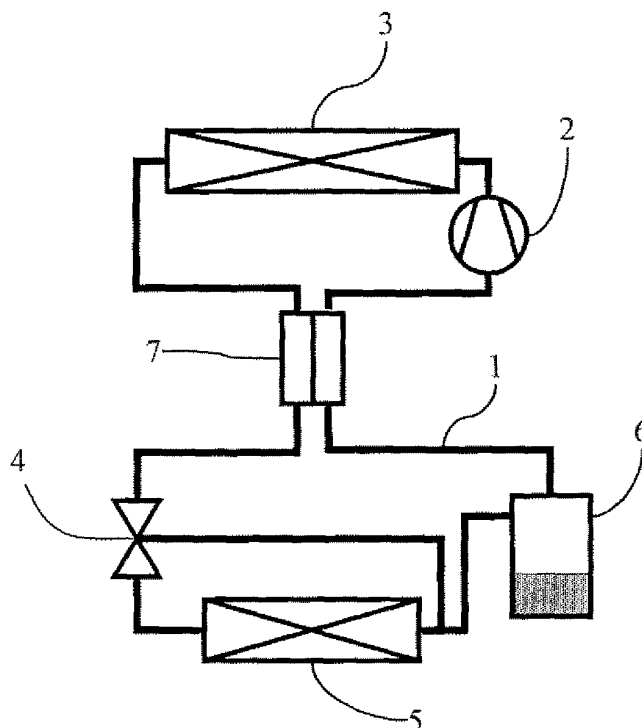
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(54) **Pressure reduce module with oil separator**

(57) A pressure reducer module includes an oil separator configured to receive a lubricant and a refrigerant and to separate the lubricant from the refrigerant. The pressure reducer module also includes a pressure re-

ducer connected to and termed integral with the oil separator. The pressure reducer is configured to receive the refrigerant from the oil separator and to reduce a pressure of the refrigerant.

FIG. 1



Description

[0001] The present invention relates generally to a pressure reducer module with oil separator configured to be used in a vapor compression refrigerating system.

[0002] In a known vapor compression refrigerating system, such as the vapor compression refrigerating system described in Japanese Patent Publication No. JP-A-11-193967, a refrigerant sequentially is compressed by a compressor, cooled and reduced in pressure by a radiator, and evaporated by an evaporator to obtain a refrigerant with refrigerating ability. In such a known vapor compression refrigerating system, when a natural-system refrigerant, such as carbon dioxide, is used as a refrigerant instead of a Freon-group refrigerant, it is necessary to elevate the pressure of the high pressure side to at least a critical pressure of the refrigerant. Moreover, because the consumption power required for the compressor increases substantially, the efficiency of the refrigerating system decreases substantially.

[0003] In one known method for increasing the efficiency of the refrigerating system, the amount of lubricant included in the refrigerant circulated in the refrigerating system is reduced to prevent the reduction of the coefficient of heat transfer at the evaporator. Specifically, reducing the amount of lubricant which flows into the evaporator accelerates the heat transfer of the evaporator, which increases the efficiency of the refrigerating system.

[0004] Fig. 6 depicts a known refrigerating system 101. Refrigerating system 101 comprises a compressor 102, a radiator 103 for cooling refrigerant which flows from compressor 102, an inside heat exchanger 105 for exchanging heat between a high-temperature refrigerant which flows from radiator 103 and a low-temperature refrigerant which flows from an accumulator 104. Inside heat exchanger 105 functions as a gas/liquid separator and supplies the refrigerant to compressor 102 after the exchange of heat between the high-temperature refrigerant and the low-temperature refrigerant. Refrigerating system 101 also comprises a pressure reducer 106 for reducing the pressure of refrigerant which flows from heat exchanger 105, an evaporator 107 for evaporating refrigerant which flows from pressure reducer 106, and accumulator 104 for storing gas/liquid two phase refrigerant from evaporator 107 and for supplying gas-phase refrigerant to the inside of heat exchanger 105.

[0005] Therefore, a need has arisen for vapor compression refrigerating systems which overcome these and other shortcomings of the related art. A technical advantage of the present invention is that a pressure reducer module may comprise an oil separator and may be configured to transmit a refrigerant to an evaporator while allowing a lubricant to bypass the evaporator, which substantially reduces the amount of lubricant flowing into the evaporator, which increases the efficiency of the refrigerating system by increasing the coefficient of heat transfer of the evaporator. Another technical advantage of the present invention may be obtained by providing a

pressure reducer module with oil separator which may reduce the number of coupling portions and reduce the weight and the cost of the system when the system.

[0006] According to an embodiment of the present invention, a pressure reducer module comprises an oil separator configured to receive a lubricant and a refrigerant and to separate the lubricant from the refrigerant. The pressure reducer module also comprises a pressure reducer connected to and formed integral with the oil separator. The pressure reducer is configured to receive the refrigerant from the oil separator and to reduce a pressure of the refrigerant.

[0007] Other objects, features, and advantage will be apparent to persons of ordinary skill in the art from the following detailed description of the invention and the accompanying drawings.

[0008] For a more complete understanding of the present invention, needs satisfied thereby, and the objects, features, and advantages thereof, reference now is made to the following description taken in connection with the accompanying drawings.

Fig. 1 is a circuit diagram of a vapor compression refrigerating system having a pressure reducer module with oil separator, according to an embodiment of the present invention.

Fig. 2 is a vertical, sectional view of a pressure reducer module with oil separator, according to an embodiment of the present invention.

Fig. 3 is a cross-sectional view of the pressure reducer module with oil separator of Fig. 2, as viewed along line A-A.

Fig. 4 is a Mollier chart of the vapor compression refrigerating system of Fig. 1.

Fig. 5 is a vertical, sectional view of a pressure reducer module with oil separator, according to another embodiment of the present invention.

Fig. 6 is a circuit diagram of a known vapor compression refrigerating system.

[0009] Embodiments of the present invention, and their features and advantages, may be understood by referring to Figures 1-5, like numerals being used for like corresponding parts in the various drawings.

[0010] Fig. 1 depicts a vapor compression refrigerating system having a pressure reducer module with oil separator, according to an embodiment of the present invention. The refrigerating system 1 may use a natural-system refrigerant, such as carbon dioxide. In this embodiment, the refrigerating system 1 may comprise a compressor 2, a radiator 3 connected to compressor 2, an inside heat exchanger 7 connected to radiator 3 and to compressor 2, and a pressure reducer module with oil separator 4 connected to inside heat exchanger 7. The refrigerating system also may comprise an evaporator 5 connected to pressure reducer module with oil separator 4, and a gas/liquid separator 6 connected to the evaporator 5 and to inside heat exchanger 7. In the refrigeration system,

the connections between the various components may be made via a tube 1.

[0011] In operation, compressor 2 may compress the refrigerant, radiator 3 may radiate the refrigerant and reduce a temperature of the refrigerant received from compressor 2, evaporator 5 may evaporate the refrigerant received from pressure reducer module with oil separator 4, gas/liquid separator 6 may separate a gas portion of the refrigerant from a liquid portion of the refrigerant received from evaporator 5, and inside heat exchanger 7 may exchange heat between the refrigerant sent from radiator 3 and the refrigerant sent from gas/liquid separator 6

[0012] Figs. 2 and 3 depict an exemplary pressure reducer module with oil separator 4, according to an embodiment of the present invention. In this example, refrigerant and a lubricant, e.g., oil, flow from heat exchanger 7 into pressure reducer module with oil separator 4 via a high pressure side refrigerant inlet 8, and only refrigerant flows to evaporator 5 via a high pressure side refrigerant outlet 9. Refrigerant also flows from evaporator 5 into pressure reducer module with oil separator 4 via a low pressure side refrigerant inlet 10, and refrigerant and lubricant separated on the high pressure side flows out of pressure reducer module with oil separator 4 via a low pressure side refrigerant outlet 11. A high pressure side refrigerant passage 19 and a low pressure side refrigerant passage 20 are formed in a module body 18, e.g., a block, and pressure reducer module with oil separator 4 may be handled and attached as a single part.

[0013] The operation will be explained for the refrigerating system where the refrigerant at the high pressure side inlet is operated as a liquid phase, as depicted in Fig. 4 as a Mollier chart. With respect to the route of the refrigerant and the lubricant in pressure reducer module with oil separator 4, first, the refrigerant and lubricant pass through a filter 15 provided for trapping foreign matters circulated in the refrigerating system, and then flow into an oil separator 12. The refrigerant and lubricant revolve in oil separator 12 and agitate the interior of oil separator 12. At that time, because the specific gravity of lubricant is greater than that of refrigerant, the refrigerant and lubricant separate from each other by centrifugal separation. Specifically, the lubricant is gathered at the side of the inner wall surface, flows down along the inner wall surface by gravity, and is stored at a portion adjacent to the bottom surface. The liquid refrigerant passes through the interior of a pipe provided in oil separator 12, flows out from the oil separator, has its pressure reduced by a pressure reducer 13 and is turned into a two-phase condition, and it flows out from high pressure side refrigerant outlet 9. In this example, pressure reducer 13 may be a variable pressure reducer, and may adjust a degree of pressure reduction by pressure reducing movable part 16 and spring 17. Moreover, the separation of lubricant is carried out at point A in the Mollier chart depicted in Fig. 4 or in the vicinity thereof.

[0014] The lubricant that is stored adjacent to the bot-

tom surface of oil separator 12 flows from a high pressure side refrigerant passage 19 to a low pressure side refrigerant passage 20 through a lubricant passage 14 by a pressure difference between passages 19 and 20, and then flows with the low pressure side refrigerant from low pressure side refrigerant outlet 11. Therefore, the separated lubricant is substantially sent to gas/liquid separator 6 and to compressor 2 bypassing evaporator 5, as depicted in Fig. 1. Moreover, lubricant passage 14 may have a small hole shape, such that high pressure side refrigerant does not easily flow out to low pressure side refrigerant passage 20, and such that only lubricant is easily flowed out from high pressure side refrigerant passage 19 to low pressure side refrigerant passage 20. Further, low pressure side refrigerant passage 20 is inclined from inlet 10 toward outlet 11 to prevent the reverse flow of lubricant which flows from lubricant passage 14 from the low pressure side refrigerant entrance 10 to evaporator 5.

[0015] Fig. 5 depicts another example of a pressure reducer module with oil separator. In this embodiment, a pressure reducer is disposed before an oil separator. In operation, refrigerant and a lubricant flow into pressure reducer module with oil separator 4 from high pressure side refrigerant inlet 8, and after being reduced in pressure at pressure reducer 13, flows into oil separator 12 which separates the refrigerant from the lubricant. The refrigerant then flows through a pipe in oil separator 12 from the oil separator outlet to high pressure side refrigerant outlet 9, and the lubricant is stored adjacent to the bottom surface in oil separator 12, flows down from high pressure side refrigerant passage 19 to low pressure side refrigerant passage 20 through lubricant passage 14, and flows from low pressure side refrigerant outlet 11 with the low pressure side refrigerant. In this example depicted in Fig. 5, the separation of lubricant is carried out at point B in the Mollier chart depicted in Fig. 4 or the vicinity thereof.

[0016] In the above-described examples, pressure reducer 13 may comprise a mechanism for determining a degree of pressure reduction based on information concerning a condition of the refrigerating system. In one embodiment, the condition of the refrigerating system may be a pressure difference of refrigerant between the inlet and the outlet of the pressure reducer. Pressure reducer 13 depicted in Fig. 2 comprises such a mechanism, in which pressure reducing movable part 16 moves by a balance between the inlet refrigerant pressure of pressure reducer 13 and the urging force of spring 17, thereby changing the cross-sectional area of refrigerant passage and adjusting the degree of pressure reduction.

[0017] Where, the mechanism for adjusting the degree of pressure reduction of the pressure reducer may be a mechanism for determining the degree of pressure reduction univocally from refrigerant pressure, refrigerant temperature, etc. of the refrigerating system. Further, the mechanism may be a mechanism formed by attaching a solenoid valve to a pressure reducing degree adjusting mechanism for determining a degree of pressure reduc-

tion based on information concerning refrigerant pressure, refrigerant temperature, air temperature at the exit of the evaporator, etc.

[0018] Further, the portion of the main body of pressure reducer module with oil separator 4 may be formed, such that the high pressure side refrigerant inlet and the high pressure side refrigerant outlet for forming the high pressure side refrigerant passage, and the low pressure side refrigerant inlet and the low pressure side refrigerant outlet for forming the low pressure side refrigerant passage, are disposed on a single structural body, and by this structure, the connection of pipes 1 may be facilitated.

[0019] The pressure reducer module with oil separator according to the present invention may be used in a vapor compression refrigerating system for compressing and expanding refrigerant, and particularly, may be used a vapor compression refrigerating system using carbon dioxide as a refrigerant, such as a refrigerating system used in an air conditioning system for a vehicle.

Claims

1. A pressure reducer module comprising:

an oil separator configured to receive a lubricant and a refrigerant and to separate the lubricant from the refrigerant; and

a pressure reducer connected to and formed integral with the oil separator, wherein the pressure reducer is configured to receive the refrigerant from the oil separator and to reduce a pressure of the refrigerant.

2. The pressure reducer module of claim 1. further comprising:

a first passage coupled to an inside heat exchanger, wherein the oil separator and the pressure reducer are positioned within the first passage, and the first passage is configured to receive the refrigerant and the lubricant from the inside heat exchanger, to transmit the refrigerant and lubricant to the oil separator, and to transmit the refrigerant to the pressure reducer; a second passage coupled to an evaporator, wherein the second passage is configured to receive the refrigerant from the evaporator after the refrigerant flows from the pressure reducer to the evaporator; and

a lubricant passage connected to the first passage and the second passage, wherein the lubricant passage is configured to introduce the lubricant from the oil separator to the second passage.

3. The pressure reducer module of claim 2, wherein the second passage comprises a second passage

inlet coupled to the evaporator and a second passage outlet, wherein the second passage is slanted, such the second passage inlet is positioned above the second passage outlet and the lubricant introduced into the second passage flows toward the second passage outlet.

4. The pressure reducer module of claim 2, further comprising a filter, wherein the first passage comprises a first passage inlet and a first passage outlet, the filter is positioned between the first passage inlet and the first passage outlet, and the filter is configured to substantially prevent foreign matter from passing through the first passage.

5. The pressure reducer module of claim 1, wherein the pressure reducer has a mechanism which determines a degree of pressure reduction based on information concerning a condition of the vapor compression refrigerating system.

6. The pressure reducer module of claim 1, wherein the first passage inlet, the second passage inlet, the first passage outlet, and the second passage outlet are formed in a single block.

7. The pressure reducer module of claim 1, wherein the refrigerant comprises carbon dioxide.

8. A vapor compression refrigerating system comprising the pressure reducer module of claim 1.

9. An air conditioning system comprising the vapor compression refrigerating system of claim 8.

FIG. 1

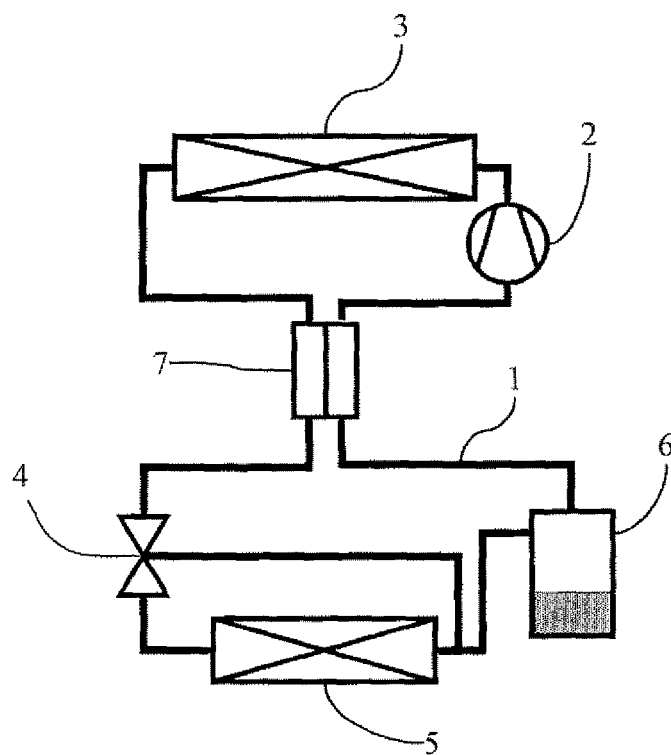


FIG. 2

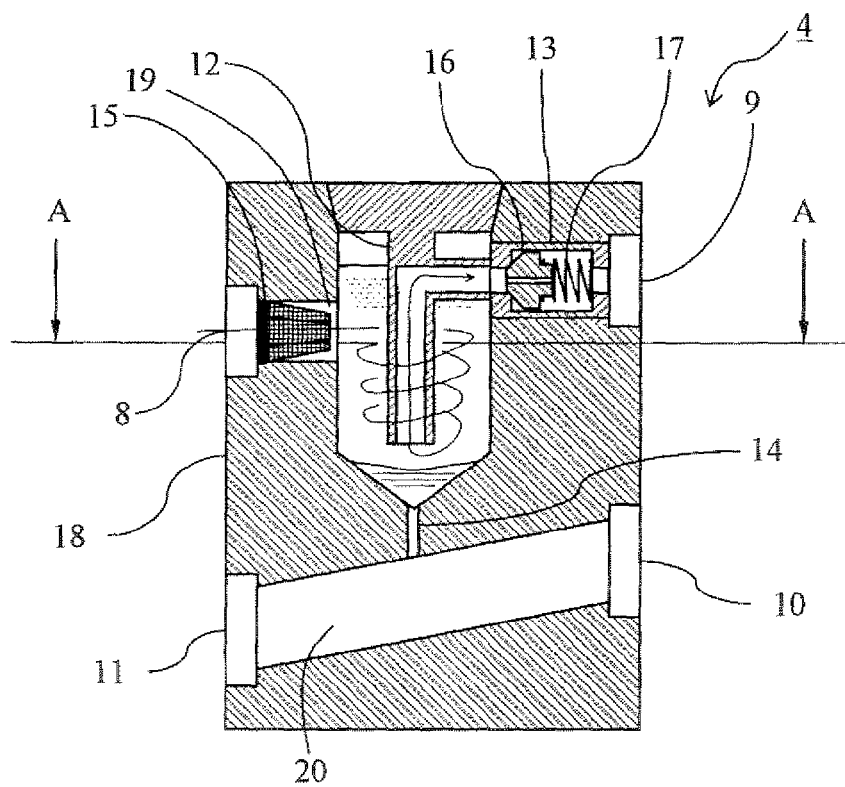


FIG. 3

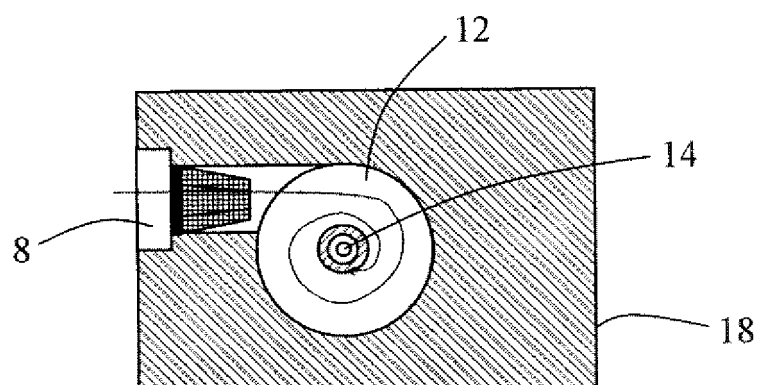


FIG. 4

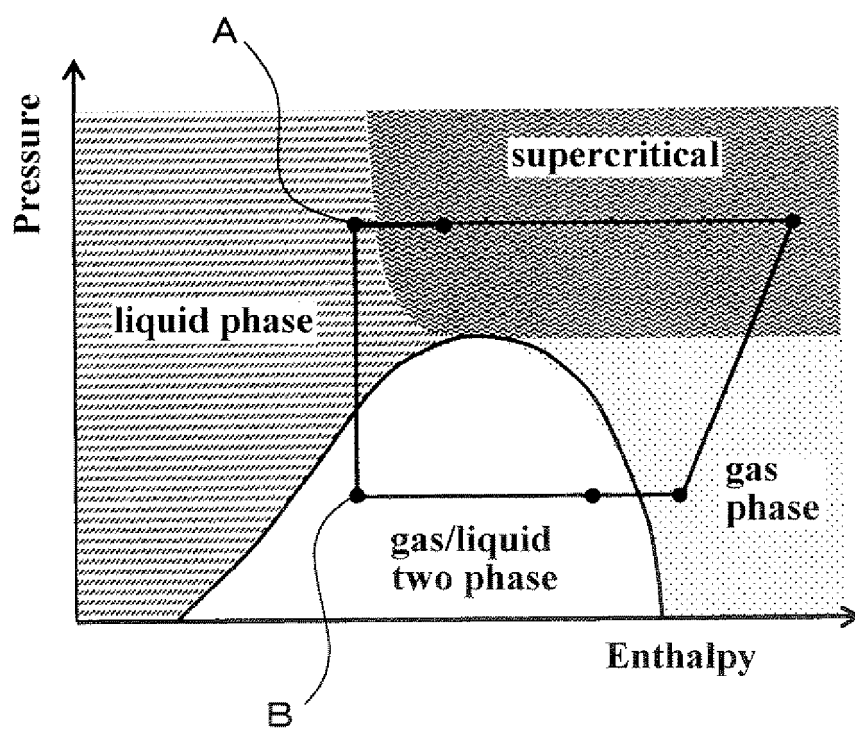


FIG. 5

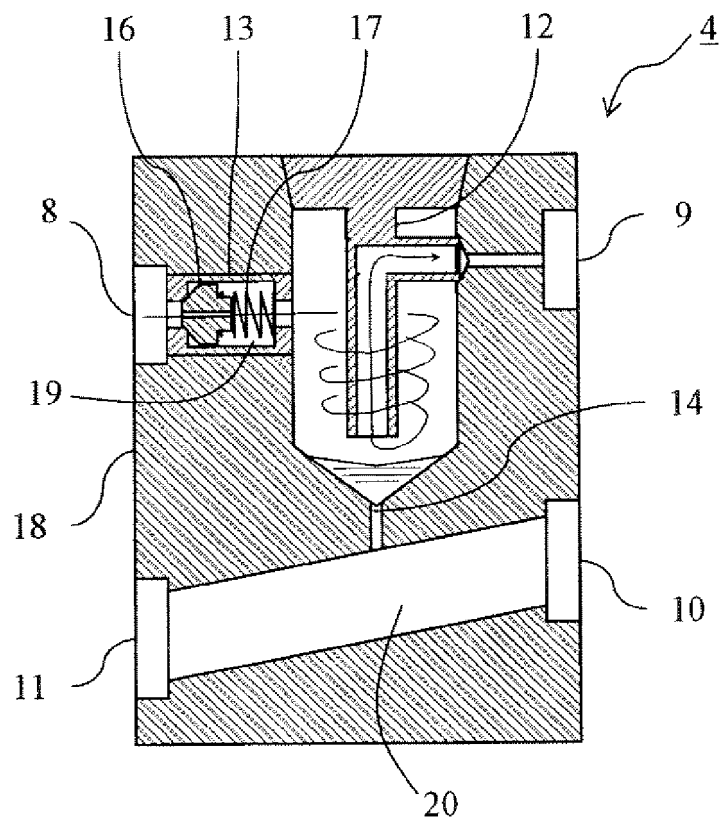
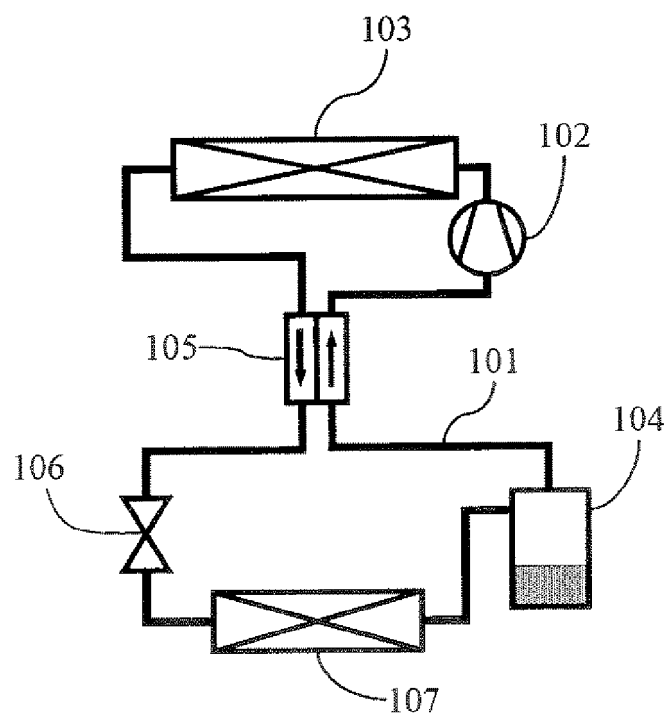


FIG. 6



REFERENCES CITED IN THE DESCRIPTION

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