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(54) DUAL TURBO CENTRIFUGAL CHILLER

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(57) ABSTRACT

A dual turbo centrifugal chiller includes: first and second evaporators connected in series or in parallel; first and second condensers connected in series or in parallel; and first and second compressors including impellers, wherein cold water passes through the second evaporator after passing through the first evaporator, and cooling water passes through the second condenser after passing through the first condenser, the first compressor containing a refrigerant connects the first condenser to the second evaporator, and the second compressor containing a refrigerant connects the second condenser to the first evaporator, and the impellers of the first compressor and second compressor are rotated simultaneously using a single driving unit.

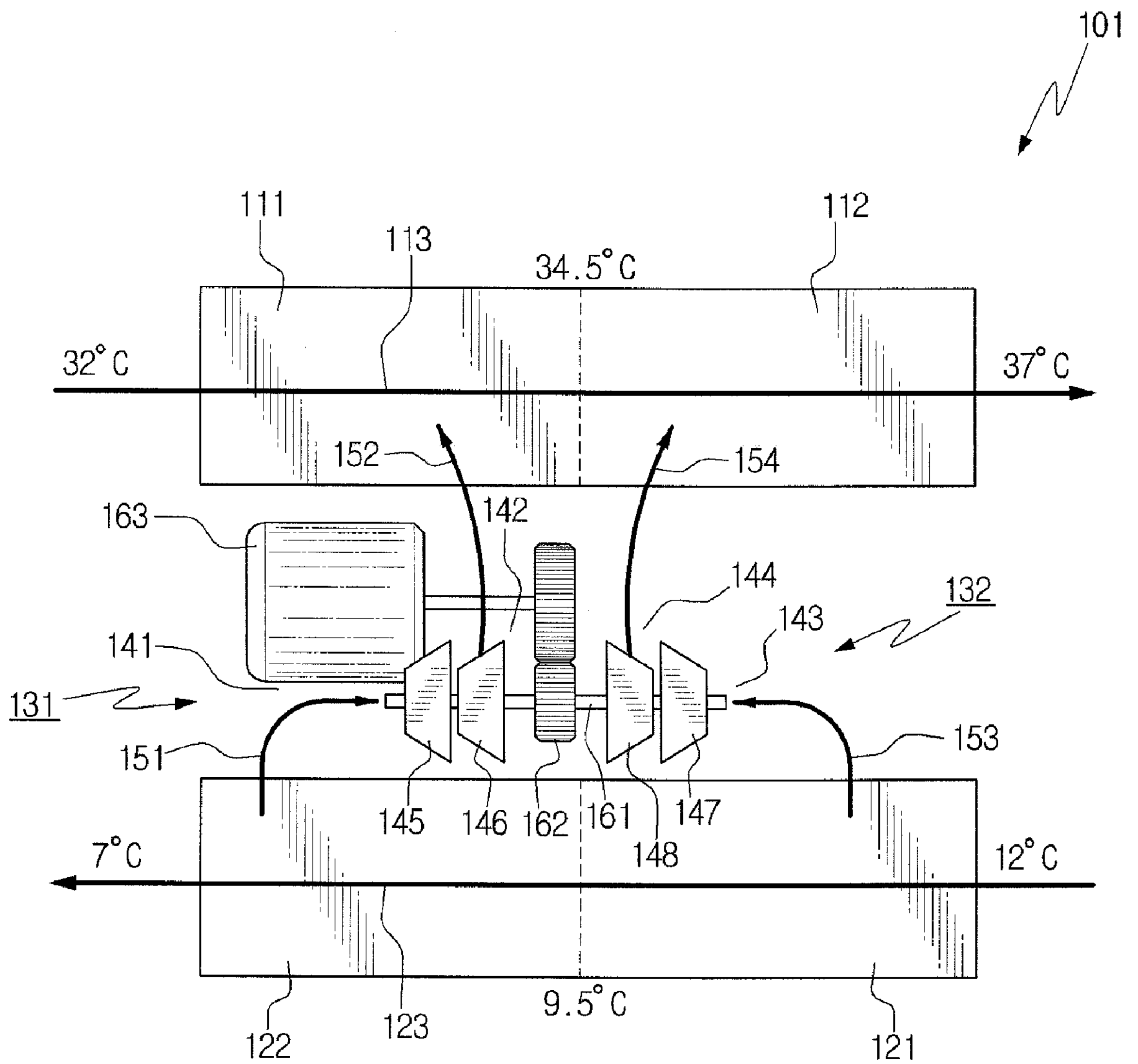


FIG. 1

(Prior Art)

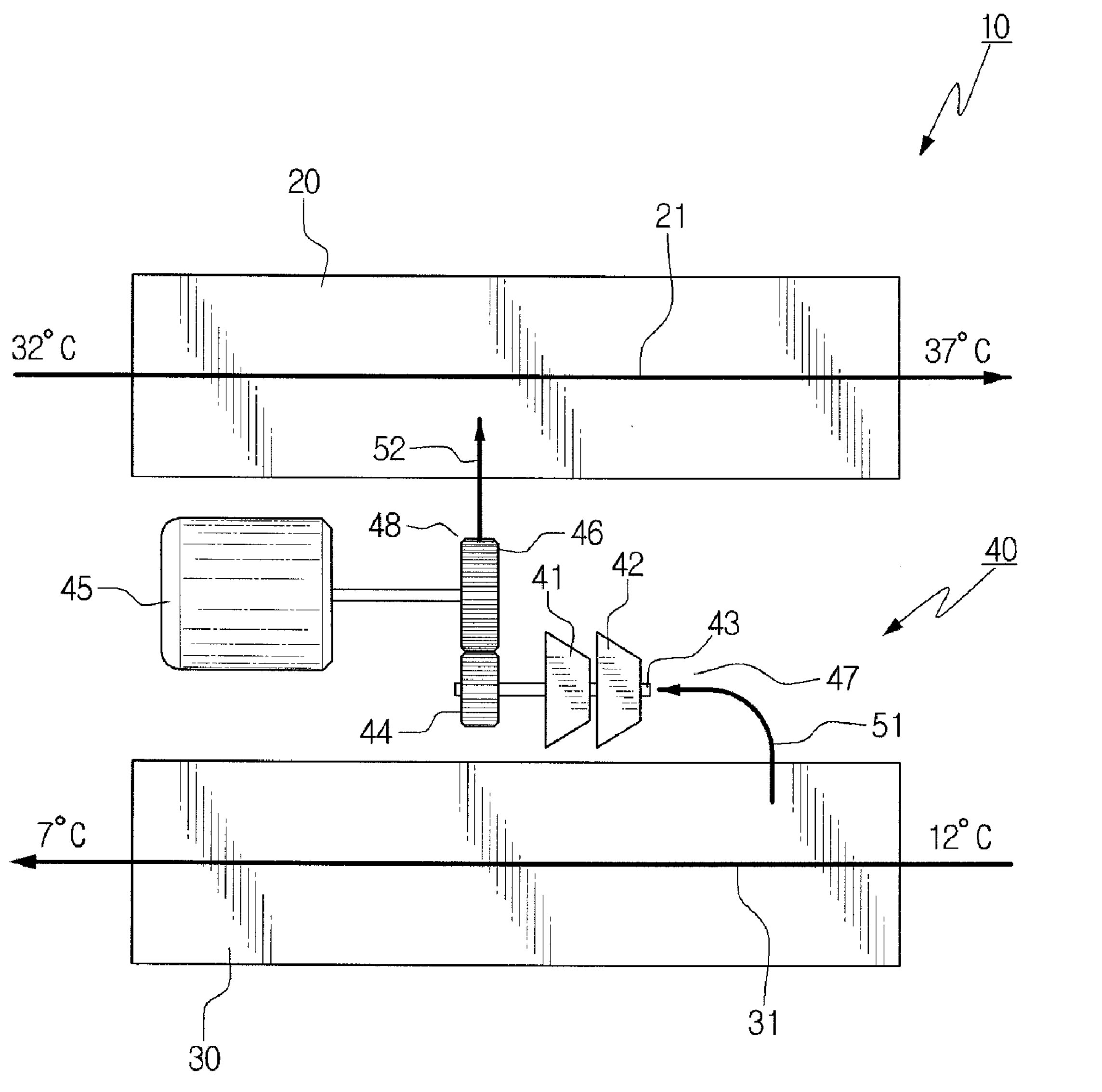


FIG. 2

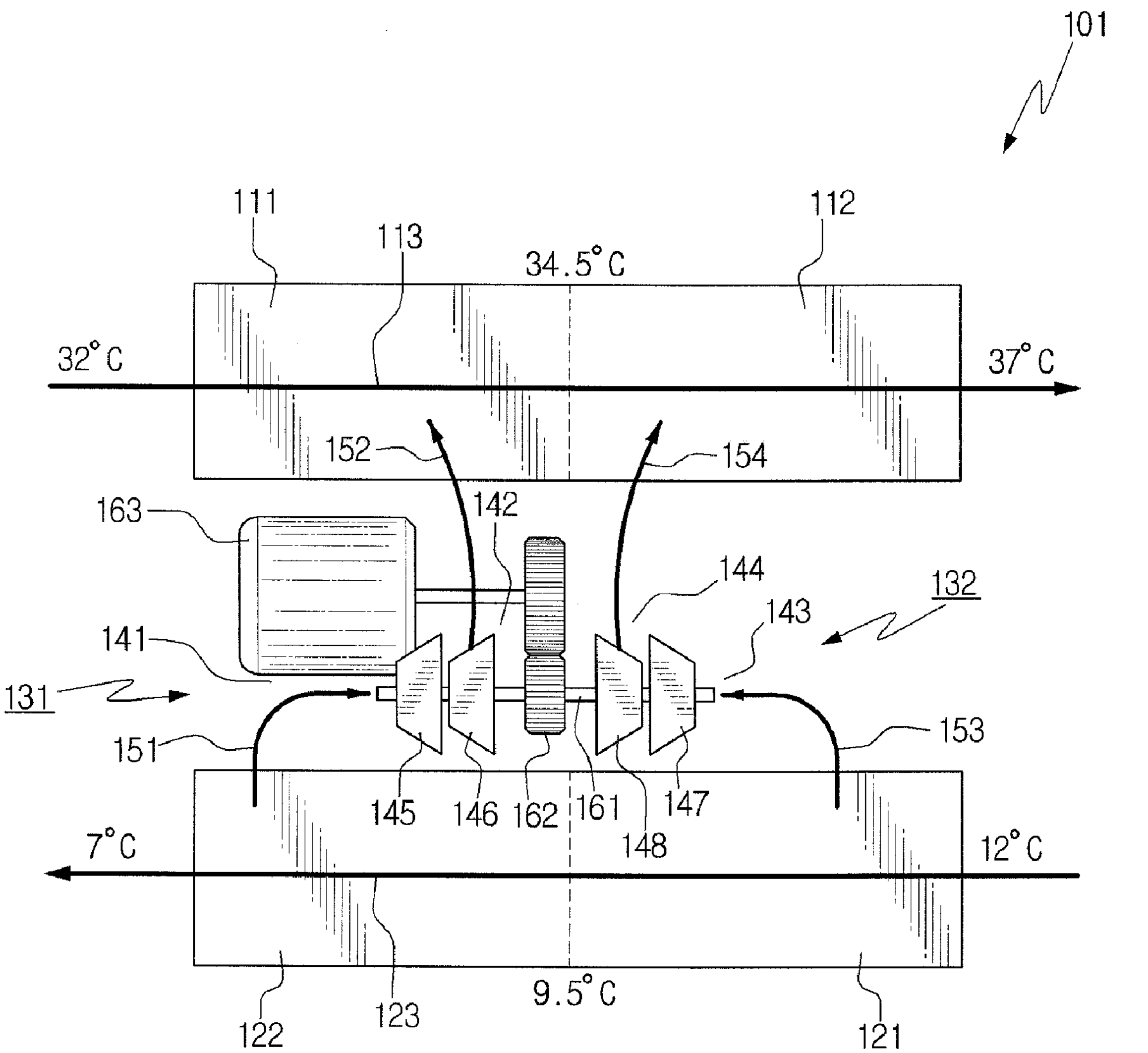
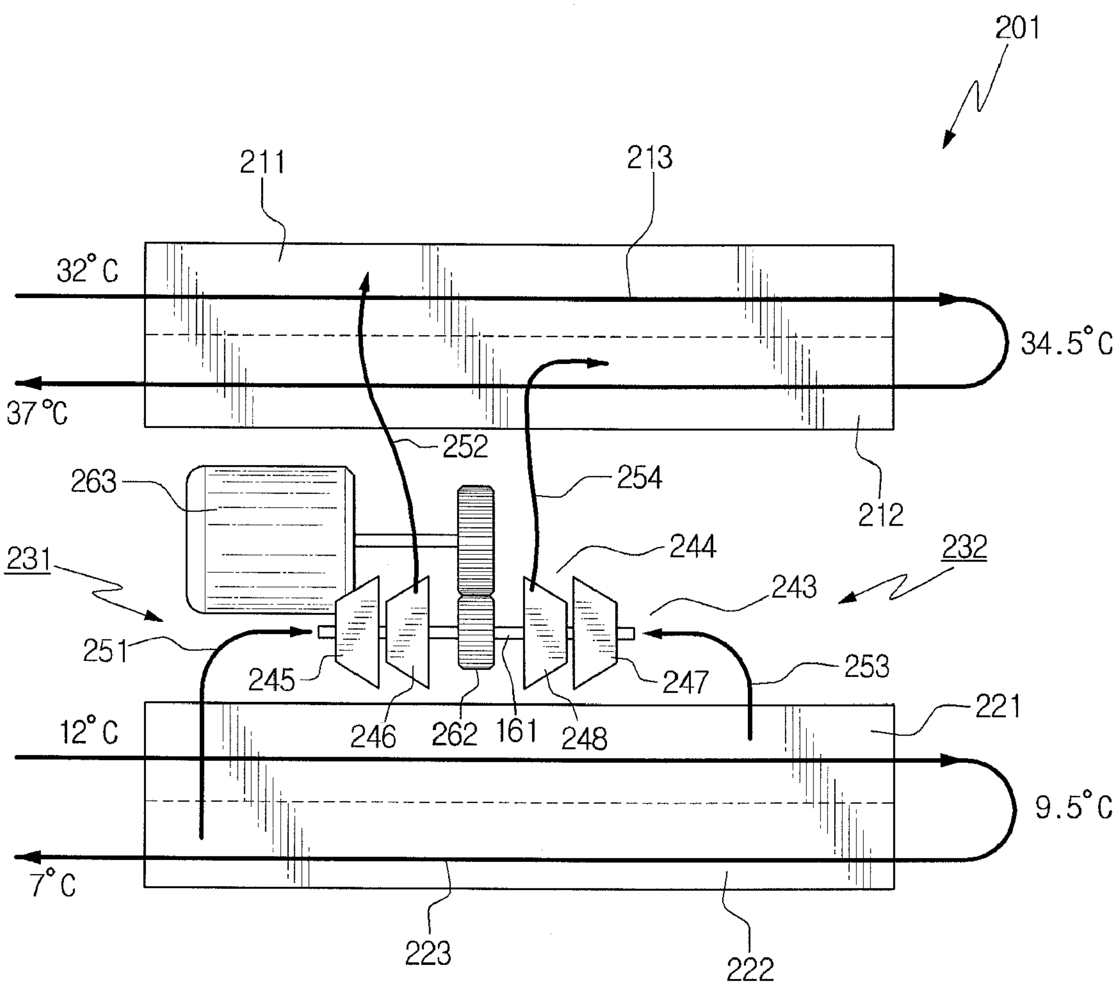

101
111
112
113
34.5° C
32° C
37° C
152
154
163
142
144
132
143
141
131
151
153
145
146
162
161
147
148
7° C
12° C
122
123
9.5° C
121

FIG. 3


201
211
213
32° C
34.5° C
37 °C
252
254
263
212
231
244
232
243
251
253
245
247
221
12° C
246
262
161
248
9.5° C
7° C
223
222

DUAL TURBO CENTRIFUGAL CHILLER

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to Korean Patent Application No. 10-2009-0102209, filed on Oct. 27, 2009, and all the benefits accruing therefrom under 35 U.S.C. §119, the contents of which in its entirety are herein incorporated by reference.

BACKGROUND

[0002] 1. Field

[0003] This disclosure relates to a dual turbo centrifugal chiller, particularly to a dual turbo centrifugal chiller configured to decrease head of a compressor among components of two individual chillers, decrease the size of the chiller, and increase efficiency.

[0004] 2. Description of the Related Art

[0005] A general chiller includes a compressor, an evaporator, a condenser, and an expansion valve, and circulates a refrigerant to transfer heat from the evaporator to the condenser through heat exchange.

[0006] FIG. **1** is a diagram schematically illustrating a general chiller **10**.

[0007] As illustrated in FIG. **1**, the chiller **10** includes an evaporator **30**, a condenser **20**, and a compressor **40**. Cold water **31** flows through the evaporator **30**, and cooling water **21** flow through the condenser **20**.

[0008] The compressor **40** in which a refrigerant **51**, **52** is circulated connects the evaporator **30** to the condenser **20**. The refrigerant **51** that passes through the evaporator **30** flows into the compressor **40** through an inlet portion **47** of the compressor **40**, and the refrigerant **52** compressed by two-stage impellers **41** and **42** flows out of an outlet portion **48** of the compressor **40** and then flows into the condenser **20**.

[0009] As illustrated in FIG. **1**, in the compressor **40**, the two-stage impellers **41** and **42** are provided on a shaft **43**, and the impellers **41** and **42** are rotated as the shaft **43** is rotated by a motor **45**. Here, gears **44** and **46** are provided to connect the motor **45** to the shaft **43** so as to transmit torque. Although not shown in the figure, a thrust bearing may be connected between the gear **44** and the shaft **43**.

[0010] In the general compressor **40**, a load applied to the bearing increases because a thrust that is transferred to the gears **46** and **44** is focused in one direction, and, thus, a load applied to the motor **45** also increases. As the load applied to the motor **45** increases, an outlet temperature of the cold water increases, which results in an increase in head of the compressor. As a result, the efficiency of the compressor is decreased.

[0011] In order to decrease the head of the compressor and increase the efficiency of the chiller, a 'dual turbo centrifugal chiller' which includes two chillers connected to each other has been used. The dual turbo centrifugal chiller has an increased capacity by increasing the chilling efficiency of the chiller itself. In the dual turbo centrifugal chiller, two compressors are provided. However, in the existing dual turbo centrifugal chiller, one of the two compressors has a higher head than the other. Therefore, the two compressors have to be independently designed and manufactured. That is, a driving unit for driving an impeller of each of the compressors is additionally needed, and the entire size of the chiller is increased. Accordingly, as described above, there is a problem in that the efficiency of the compressor is decreased.

SUMMARY

[0012] This disclosure provides a dual turbo centrifugal chiller in which two compressors, two evaporators, and two condensers are included to decrease heads of the compressors, the compressors are configured to operate with the same head, and impellers of the compressors are driven by a single driving unit, thereby achieving a decrease in size and an increase in efficiency.

[0013] In one aspect, there is a provided a dual turbo centrifugal chiller including: first and second evaporators connected in series or in parallel; first and second condensers connected in series or in parallel; and first and second compressors including impellers, wherein cold water passes through the second evaporator after passing through the first evaporator, and cooling water passes through the second condenser after passing through the first condenser, the first compressor containing a refrigerant connects the first condenser to the second evaporator, and the second compressor containing a refrigerant connects the second condenser to the first evaporator, and the impellers of the first compressor and the second compressor are rotated simultaneously using a single driving unit.

[0014] In addition, the impellers of the first and second compressors may be connected with a single rotation shaft, and the impellers of the first and second compressors may be rotated simultaneously as the rotation shaft is rotated using the driving unit.

[0015] In addition, the driving unit may be connected to the center of the rotation shaft, and the impellers of the first and second compressors may be opposed with the center of the rotation shaft between them.

[0016] In addition, inlet portions of the first and second compressors may be provided with inlet guide vanes (IGVs) respectively.

[0017] In addition, the first and second compressors may have different capacities from each other.

[0018] Since the dual turbo centrifugal chiller including the two evaporators, the two compressors and the two condensers maintains the reduced head of each compressor, it is possible to achieve the optimal performance of the compressor.

[0019] In addition, since the impellers of the two compressors are driven simultaneously using the single driving unit, it is possible to implement the compressor having a small size and high efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The above and other aspects, features and advantages of the disclosed exemplary embodiments will be more apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

[0021] FIG. **1** is a diagram schematically illustrating a general chiller;

[0022] FIG. **2** is a diagram schematically illustrating a dual turbo centrifugal chiller according to an embodiment; and

[0023] FIG. **3** is a diagram schematically illustrating a dual turbo centrifugal chiller according to another embodiment.

DETAILED DESCRIPTION

[0024] Exemplary embodiments now will be described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments are shown. This disclosure may, however, be embodied in many different forms and should not be construed as limited to the exemplary embodiments set forth therein. Rather, these exemplary embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of this disclosure to those skilled in the art. In the description, details of well-known features and techniques may be omitted to avoid unnecessarily obscuring the presented embodiments.

[0025] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of this disclosure. As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. Furthermore, the use of the terms a, an, etc. does not denote a limitation of quantity, but rather denotes the presence of at least one of the referenced item. It will be further understood that the terms “comprises” and/or “comprising”, or “includes” and/or “including” when used in this specification, specify the presence of stated features, regions, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, regions, integers, steps, operations, elements, components, and/or groups thereof.

[0026] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and the present disclosure, and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0027] In the drawings, like reference numerals in the drawings denote like elements. The shape, size and regions, and the like, of the drawing may be exaggerated for clarity.

[0028] FIG. **2** is a diagram schematically illustrating a dual turbo centrifugal chiller **101** according to an embodiment.

[0029] As illustrated in FIG. **2**, according to the embodiment, a first evaporator **121** and a second evaporator **122** are connected in series. Cold water **123** flows into an end of the first evaporator **121** connected in series, passes through the first evaporator **121**, passes through the second evaporator **122**, and then flows out.

[0030] A first condenser **111** and a second condenser **112** are connected in series. Cooling water **113** passes through the first condenser **111**, flows into the second condenser **112**, passes through the second condenser **112**, and then flows out.

[0031] A first compressor **131** is connected to the first condenser **111** and the second evaporator **122** such that a refrigerant of the first compressor **131** is circulated to exchange heat with the cooling water **113** of the first condenser **111** and the cold water **123** of the second evaporator **122**. A second compressor **132** is connected to the second condenser **112** and the first evaporator **121** such that a refrigerant of the second compressor **132** is circulated to exchange heat with the cooling water **113** of the second compressor **112** and the cold water **123** of the first evaporator **121**.

[0032] A temperature of the cold water that flows into the first evaporator **121** is 12° C., a temperature of the cold water that flows out of the second evaporator **122** is 7° C., a temperature of the cooling water that flows into the first condenser **111** is 32° C., and a temperature of the cooling water that flows out of the second condenser **112** is 37° C.

[0033] Without consideration of leaving temperature differences (LTDs) of the evaporator and the condenser, a head of the first compressor **131** is 27.5° C. (34.5° C.-7° C.), and a head of the second compressor **132** is also 27.5° C. (37° C.-9.5° C.).

[0034] In the dual turbo centrifugal chiller **101** according to the embodiment, as described above, the heads of the two compressors **131** and **132** are equal to each other. Accordingly, as described below, a design for simultaneously driving impellers of the two compressors using a single driving unit may be easily achieved.

[0035] Hereinafter, configurations of the two compressors **131** and **132** according to the embodiment will be described with reference to FIG. **2**.

[0036] According to the embodiment, the first compressor **131** is a two-stage compression system having two impellers **145** and **146**. A refrigerant **151** flows out of the second evaporator **122** into the first compressor **131** through an inlet portion **141** of the first compressor **131**, and the refrigerant is compressed while passing through the impellers **145** and **146**. The compressed refrigerant **152** flows out of the first compressor **131** through an outlet portion **142** and flows into the first condenser **111**.

[0037] The second compressor **132** is a two-stage compression system having two impellers **143** and **144**. A refrigerant **153** that flows out of the first evaporator **121** flows into the second compressor **132** through an inlet portion **143** of the second compressor **132**, and the refrigerant is compressed while passing through the impellers **143** and **144**. The compressed refrigerant **154** flows out of the second compressor **132** through an outlet portion **144** and flows into the second condenser **122**.

[0038] According to the embodiment, a single driving unit **163** for rotating the impellers **143**, **144**, **145**, and **146** of the two compressors **131** and **132** is provided. In this embodiment, an electric motor is used as the driving unit **163**.

[0039] The impellers **143**, **144**, **145**, and **146** of the two compressors **131** and **132** are connected with a rotation shaft **161**. A gear **162** is provided at the center of the rotation shaft **161**, the impellers **145** and **146** of the first compressor **131** and the impellers **143** and **144** of the second compressor **132** are opposed with the center of the rotation shaft **161** between them. An end portion of the driving unit **163** is connected to a gear, and the gear connected to the driving unit **163** is engaged with a gear **162** of the rotation shaft **161**. In this configuration, the single driving unit **163** rotates the rotation shaft **161**, and as the rotation shaft **161** is rotated, the impellers **143**, **144**, **145**, and **146** of the two compressors **131** and **132** are rotated simultaneously.

[0040] According to the embodiment, since the two individual compressors **131** and **132** are driven by the single driving unit **163**, the entire volume of the compressor system is reduced. Therefore, the entire size of the dual turbo centrifugal chiller **101** is reduced.

[0041] In addition, since the impellers of the two compressors are disposed symmetrically, thrusts applied to both ends of the gear **162** occur in the opposite direction and cancel each other out. Accordingly, a load applied to a bearing (not shown) used for the gear **162** decreases, which results in a decrease in the load applied to the driving unit **163** and an increase in the efficiency of the driving unit **163**. The increase in the efficiency of the driving unit **163** causes a decrease in the outlet temperature of the cooling water, and this causes a decrease in the heads of the compressors **131** and **132**.

Accordingly, there are advantages in that the efficiency of the entire compression system increases, and the efficiency of the entire chiller increases. In addition, in designing the bearing, a design of the bearing without concern about the thrust applied in particular direction may be achieved.

[0042] According to the embodiment, the inlet portions of the first and second compressors **131** and **132** are provided with inlet guide vanes (IGVs) for adjusting loads applied thereto in order to facilitate load adjustment.

[0043] According to the embodiment, since the first and second compressors **131** and **132** are separated from each other, various combinations of capacity may be attained with the compressors and the heat exchangers (the condensers and the evaporators). For example, the capacities of the compressors **131** and **132** may be set to 1,000 RT and 500 RT, respectively. The size of the heat exchanger is determined according to the capacity of the compressor. Even in this case, the impellers of the compressors are disposed symmetrically on the single rotation shaft, and since the impellers are disposed symmetrically, the thrust cancellation effect of the bearing is exhibited even in the case where the capacities of the two compressors are different from each other.

[0044] In this embodiment, the two evaporators **121** and **122** are connected in series, and the two condensers **111** and **112** are connected in series, however, the embodiment is not limited to that configuration. Hereinafter, another embodiment will be described with reference to FIG. **3**.

[0045] FIG. **3** is a diagram schematically illustrating a dual turbo centrifugal chiller **201** according to another embodiment.

[0046] As illustrated in FIG. **3**, in the dual turbo centrifugal chiller **201** according to this embodiment, a first evaporator **221** and a second evaporator **222** are connected in parallel. Cold water **223** flows into an end of the first evaporator **221** connected in parallel and flows out of the other end of the first evaporator **221**, flows into an end of the second evaporator **222**, passes through the second evaporator **222**, and flows out of the other end of the second evaporator **222**.

[0047] A first condenser **211** and a second condenser **212** are connected in parallel. Cooling water **213** flows into an end of the first condenser **211** connected in parallel, flows out of the other end of the first condenser **211**, flows into an end of the second condenser **212**, passes through the second condenser **212**, and flows out of the other end of the second condenser **212**.

[0048] A first compressor **231** is connected to the first condenser **211** and the second evaporator **222**, and a refrigerant of the first compressor **231** is circulated to exchange heat with the cooling water of the first condenser **211** and the cold water of the second evaporator **222**. A second compressor **232** is connected to the second condenser **212** and the first evaporator **221**, and a refrigerant of the second compressor **232** is circulated to exchange heat with the cooling water of the second condenser **212** and the cold water of the first evaporator **221**.

[0049] Here, a temperature of the cold water that flows into the first evaporator **221** is 12° C., a temperature of the cold water that flows out of the second evaporator **222** is 7° C., a temperature of the cooling water that flows into the first condenser **211** is 32° C., and a temperature of the cooling water that flows out of the second condenser **212** is 37° C.

[0050] Without consideration of LTDs of the evaporators and the compressors, a head of the first compressor **231** is 27.5° C. (34.5° C.-7° C.), and a head of the second compressor **232** is also 27.5° C. (37° C.-9.5° C.). That is, the heads of the two compressors are equal to each other.

[0051] Since connection relationships between impellers **245**, **246**, **247**, and **248** of the compressors **231** and **232**, the rotation shaft **161**, a gear **262**, and a driving unit **263** provided in the dual turbo centrifugal chiller **201** according to this embodiment, and a flow of a refrigerant **251**, **252**, **253**, and **254** at inlet and outlet portions **243** and **244** of the compressor are the same as those of the embodiment illustrated in FIG. **2**, a detailed description thereof will be omitted.

[0052] Although the two embodiments of the dual turbo centrifugal chiller have been described, this disclosure is not limited thereto. That is to say, the two evaporators may be connected in serial or in parallel, and the two condensers may be connected in serial or in parallel. In this case, it should be understood by those skilled in the art that cold water passes through a first evaporator and a second evaporator, cooling water passes through a second condenser after passing through a first condenser, a first compressor containing a refrigerant is connected to the first condenser and the second evaporator, and a second compressor containing a refrigerant is connected to the second condenser and the first evaporator, thereby implementing a dual turbo centrifugal chiller in which heads of the two compressor are equal to each other.

[0053] While the exemplary embodiments have been shown and described, it will be understood by those skilled in the art that various changes in form and details may be made thereto without departing from the spirit and scope of this disclosure as defined by the appended claims.

[0054] In addition, many modifications can be made to adapt a particular situation or material to the teachings of this disclosure without departing from the essential scope thereof. Therefore, it is intended that this disclosure not be limited to the particular exemplary embodiments disclosed as the best mode contemplated for carrying out this disclosure, but that this disclosure will include all embodiments falling within the scope of the appended claims.

What is claimed is:

1. A dual turbo centrifugal chiller, comprising:

first and second evaporators connected in series or in parallel;

first and second condensers connected in series or in parallel; and

first and second compressors including impellers,

wherein cold water passes through the second evaporator after passing through the first evaporator, and cooling water passes through the second condenser after passing through the first condenser,

the first compressor containing a refrigerant connects the first condenser to the second evaporator, and the second compressor containing a refrigerant connects the second condenser to the first evaporator, and

the impellers of the first compressor and second compressor are rotated simultaneously using a single driving unit.

2. The dual turbo centrifugal chiller according to claim **1**,

wherein the impellers of the first and second compressors are connected with a single rotation shaft, and

the impellers of the first and second compressor are rotated simultaneously as the rotation shaft is rotated using the driving unit.

3. The dual turbo centrifugal chiller according to claim **2**,

wherein the driving unit is connected to the center of the rotation shaft, and the impellers of the first and second compressors are opposed with the center of the rotation shaft between them.

4. The dual turbo centrifugal chiller according to claim **1**, wherein inlet portions of the first and second compressors are provided with inlet guide vanes (IGVs) respectively.

5. The dual turbo centrifugal chiller according to claim **3**, wherein the first and second compressors have different capacities from each other.

* * * * *