United States Patent Application Publication	20250264279
Kind Code	A1
Publication Date	August 21, 2025
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HEAT EXCHANGER AND AIR CONDITIONING SYSTEM

Abstract

A heat exchanger and an air conditioning system including the heat exchanger. The heat exchanger includes heat exchange tubes and fins, with the fin including a fin body and heat exchange tube grooves formed in the fin body, into which at least one heat exchange tube is inserted. The heat exchange tube groove includes an open first groove end, a second groove end and two groove walls. At least one of the groove walls includes a plurality of heat exchange tube guiding segments, which include first and second heat exchange tube guiding segments arranged in sequence from the first groove end to the second groove end. A line connecting between two endpoints of the first heat exchange tube guiding segment is inclined at a first angle relative to a reference plane defined by the first and second directions, and a line connecting between two endpoints of the second heat exchange tube guiding segment is inclined at a second angle relative to the reference plane when viewed in a direction perpendicular to the fin body, and the second angle is greater than the first angle and less than 90 degrees. Therefore, a performance of the heat exchanger and air conditioning system may be improved.

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Family ID: **1000008453448**

Appl. No.: **19/057473**

Filed: **February 19, 2025**

Foreign Application Priority Data

CN	202410189968.7	Feb. 20, 2024

Publication Classification

Int. Cl.: **F28D7/16** (20060101)

U.S. Cl.:

CPC **F28D7/16** (20130101);

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims foreign priority benefits under 35 U.S.C. § 119 to Chinese Patent Application No. 202410189968.7 filed on Feb. 20, 2024, the content of which is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The embodiments of the present disclosure relate to a heat exchanger and an air conditioning system comprising the heat exchanger.

BACKGROUND

[0003] A heat exchanger comprises heat exchange tubes and fins, with the fins having heat exchange tube grooves that open on one side of the heat exchanger. The heat exchange tubes are inserted into the heat exchange tube grooves of the fins.

SUMMARY

[0004] The purpose of the embodiments of the present disclosure is to provide a heat exchanger and an air conditioning system comprising the heat exchanger, thereby improving a performance of the heat exchanger and the air conditioning system, for example.

[0005] An embodiment of the present disclosure provides a heat exchanger comprising: a plurality of heat exchange tubes arranged in a first direction; and a plurality of fins arranged in a second direction perpendicular to the first direction, each of which comprises a fin body and a plurality of heat exchange tube grooves formed in the fin body, with at least one of the plurality of heat exchange tubes being inserted into each of at least some of the plurality of heat exchange tube grooves, wherein the heat exchange tube groove comprises: an open first groove end and a second groove end opposite to the first groove end; and two opposite groove walls, and at least one of the two groove walls of at least one of the plurality of heat exchange tube grooves of at least one of the plurality of fins comprises a plurality of heat exchange tube guiding segments comprising: a first heat exchange tube guiding segment and a second heat exchange tube guiding segment arranged in sequence from the first groove end to the second groove end, wherein, a line connecting between two endpoints of the first heat exchange tube guiding segment is inclined at a first angle relative to a reference plane defined by the first and second directions, and a line connecting between two endpoints of the second heat exchange tube guiding segment is inclined at a second angle relative to the reference plane when viewed in a direction perpendicular to the fin body, and the second angle is greater than the first angle and less than 90 degrees.

[0006] According to the embodiments of the present disclosure, the plurality of heat exchange tube guiding segments further comprise a third heat exchange tube guiding segment between the second heat exchange tube guiding segment and the second groove end, a line connecting between two endpoints of the third heat exchange tube guiding segment is inclined at a third angle relative to the reference plane when viewed in the direction perpendicular to the fin body, and the third angle is greater than the second angle and less than 90 degrees.

[0007] According to the embodiments of the present disclosure, the plurality of heat exchange tubes comprise a plurality of rows of heat exchange tubes arranged in the first direction, each row of heat exchange tubes consisting of one heat exchange tube or a plurality of heat exchange tubes;

the one heat exchange tube or the plurality of heat exchange tubes of each of the plurality of rows of heat exchange tubes are inserted into one of the plurality of heat exchange tube grooves; and the length of at least one of the plurality of heat exchange tube grooves of at least one of the plurality of fins in a third direction perpendicular to the first and second directions is greater than a heat exchange tube size of a row of heat exchange tubes inserted therein in the third direction, in the case where the row of heat exchange tubes is consisted of one heat exchange tube, the heat exchange tube size is the size of that one heat exchange tube in the third direction, while in the case where the row of heat exchange tubes is consisted of a plurality of heat exchange tubes, the heat exchange tube size is a sum of the sizes of the plurality of heat exchange tubes in the third direction.

[0008] According to the embodiments of the present disclosure, the heat exchange tubes in the rows of the heat exchange tubes disposed in the plurality of heat exchange tube grooves of the plurality of fins comprise a plurality of columns of heat exchange tubes arranged in the third direction, and each of the plurality of columns of heat exchange tubes comprises a plurality of heat exchange tubes arranged in the first direction.

[0009] According to the embodiments of the present disclosure, a heat exchange tube in a plurality of columns of heat exchange tubes comprises a first end located on one side of the heat exchange tube in the second direction and a second end located on the other side of the heat exchange tube in the second direction; and the heat exchanger further comprises a connecting portion, through which the first ends of the heat exchange tubes in one of the plurality of columns of heat exchange tubes are connected to and in fluid communication with the first ends of the heat exchange tubes in another one of the plurality of columns of heat exchange tubes respectively; and two second collecting tubes, one of which is connected to and in fluid communication with the second ends of the heat exchange tubes in one column of heat exchange tubes, and the other of which is connected to and in fluid communication with the second ends of the heat exchange tubes in another column of heat exchange tubes respectively.

[0010] According to the embodiments of the present disclosure, the connecting portion comprises a plurality of connecting tubes, through which the first ends of the heat exchange tubes in the one column of heat exchange tubes are connected to and in fluid communication with the first ends of the heat exchange tubes in the another column of heat exchange tubes respectively.

[0011] According to the embodiments of the present disclosure, the heat exchange tubes in the one column of heat exchange tubes, the connecting tubes, and the heat exchange tubes in the another column of heat exchange tubes that are interconnected with one another are formed by a single bent tube.

[0012] According to the embodiments of the present disclosure, the heat exchange tube in a plurality of columns of heat exchange tubes comprise a first end located on one side of the heat exchange tube in the second direction and a second end located on the other side of the heat exchange tube in the second direction; the plurality of columns of heat exchange tubes comprise a first column of heat exchange tubes, a second column of heat exchange tubes, a third column of heat exchange tubes, and a fourth column of heat exchange tubes arranged in sequence in the first direction; the heat exchanger further comprises a first connecting portion and a second connecting portion, wherein the first ends of the heat exchange tubes in the first column of heat exchange tubes are connected to and in fluid communication with the first ends of the heat exchange tubes in the third column of heat exchange tubes through the first connecting portion respectively, and the first ends of the heat exchange tubes in the second column of heat exchange tubes are connected to and in fluid communication with the first ends of the heat exchange tubes in the fourth column of heat exchange tubes through the second connecting portion respectively; and two second collecting tubes, one of which is connected to and in fluid communication with the second ends of the heat exchange tubes in the first column of heat exchange tubes and the second column of heat exchange tubes respectively, and the other of which is connected to and in fluid communication with the second ends of the heat exchange tubes in the third column of heat exchange tubes and the fourth column of heat exchange tubes respectively.

[0013] According to the embodiments of the present disclosure, the first connecting portion comprises a plurality of first connecting tubes, through which the first ends of the heat exchange tubes in the first column of heat exchange tubes are connected to and in fluid communication with the first ends of the heat exchange tubes in the third column of heat exchange tubes respectively; and the second connecting portion comprises a plurality of second connecting tubes, through which the first ends of the heat exchange tubes in the second column of heat exchange tubes are connected to and in fluid communication with the first ends of the heat exchange tubes in the fourth column of heat exchange tubes respectively.

[0014] According to the embodiments of the present disclosure, the heat exchange tubes in the first column of heat exchange tubes, the first connecting tubes, and the heat exchange tubes in the third column of heat exchange tubes that are interconnected with one another are formed by a single bent tube; and the heat exchange tubes in the second column of heat exchange tubes, the second connecting tubes, and the heat exchange tubes in the fourth column of heat exchange tubes that are interconnected with one another are formed by a single bent tube.

[0015] According to the embodiments of the present disclosure, the plurality of heat exchange tube grooves comprise a plurality of columns of the heat exchange tube grooves arranged in a third direction perpendicular to the first and second directions, each of the plurality of columns of the heat exchange tube grooves comprising a plurality of heat exchange tube grooves arranged in the first direction.

[0016] According to the embodiments of the present disclosure, at least two of a plurality of heat exchange tube grooves in at least one of a plurality of columns of heat exchange tube grooves of the plurality of fins have different lengths in the third direction.

[0017] According to the embodiments of the present disclosure, a plurality of heat exchange tube grooves in at least one of a plurality of columns of heat exchange tube grooves of the plurality of fins and a plurality of heat exchange tube grooves in at least another one of a plurality of columns of heat exchange tube grooves of the plurality of fins are alternately arranged in the first direction.

[0018] According to the embodiments of the present disclosure, the width of the portion of the heat exchange tube groove where the plurality of heat exchange tube guiding segments are provided is configured to gradually decrease in a direction from the first groove end to the second groove end when viewed in the direction perpendicular to the fin body.

[0019] According to the embodiments of the present disclosure, the plurality of heat exchange tube guiding segments are straight line segments, circular arc segments, or a combination of the straight line segments and circular arc segments when viewed in the direction perpendicular to the fin body.

[0020] According to the embodiments of the present disclosure, a total size of the plurality of heat exchange tube guiding segments in the direction from the first groove end to the second groove end is ¼ of the size of the heat exchange tube groove.

[0021] According to the embodiments of the present disclosure, at least one portion of at least one groove wall of the heat exchange tube groove located between the plurality of heat exchange tube guiding segments and the second groove end is substantially perpendicular to the reference plane.

[0022] According to the embodiments of the present disclosure, a gap between at least one portion of at least one groove wall of the heat exchange tube groove located between the plurality of heat exchange tube guiding segments and the second groove end and the heat exchange tube is less than or equal to 0.15 mm.

[0023] According to the embodiments of the present disclosure, the two groove walls of the heat exchange tube groove are symmetrical or asymmetrical relative to a centerline of the heat exchange tube groove perpendicular to the first and second directions when viewed in the direction perpendicular to the fin body.

[0024] According to the embodiments of the present disclosure, one of the two endpoints of the

first heat exchange tube guiding segment that is close to the second heat exchange tube guiding segment and one of the two endpoints of the second heat exchange tube guiding segment that is close to the first heat exchange tube guiding segment are configured to substantially overlap with each other when viewed in the direction perpendicular to the fin body.
[0025] According to the embodiments of the present disclosure, one of the two endpoints of the first heat exchange tube guiding segment that is close to the second heat exchange tube guiding segment and one of the two endpoints of the second heat exchange tube guiding segment that is close to the first heat exchange tube guiding segment are configured to substantially overlap with each other, and one of the two endpoints of the second heat exchange tube guiding segment that is close to the third heat exchange tube guiding segment and one of the two endpoints of the third heat exchange tube guiding segment that is close to the second heat exchange tube guiding segment are configured to substantially overlap with each other when viewed in the direction perpendicular to the fin body.
[0026] According to the embodiments of the present disclosure, the first heat exchange tube guiding segment and the third heat exchange tube guiding segment are straight line segments, and the second heat exchange tube guiding segment is a circular arc segment when viewed in the direction perpendicular to the fin body.
[0027] According to the embodiments of the present disclosure, at least one of the plurality of heat exchange tubes is inserted into each of the plurality of the heat exchange tube grooves.
[0028] The embodiments of the present disclosure also provide an air conditioning system comprising the heat exchanger as described above.
[0029] By using the heat exchanger according to the embodiments of the present disclosure and the air conditioning system comprising the heat exchanger, for example, the performance of the heat exchanger and the air conditioning system may be improved.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0030] FIG. **1** is a schematic front view of a heat exchanger according to an embodiment of the present disclosure;
[0031] FIG. **2** is a schematic right side view of the heat exchanger shown in FIG. **1**;
[0032] FIG. **3** is a schematic top view of a heat exchanger according to an embodiment of the present disclosure, in which only one fin and several heat exchange tubes are shown;
[0033] FIG. **4** is a schematic enlarged view of a part A of the heat exchanger shown in FIG. **3**;
[0034] FIG. **5** is a schematic top view of a fin of the heat exchanger shown in FIG. **3**;
[0035] FIG. **6** is a schematic enlarged view of a part B of the fin of the heat exchanger shown in FIG. **5**;
[0036] FIG. **7** is a schematic perspective view of a heat exchanger according to an embodiment of the present disclosure, in which only several fins and several heat exchange tubes are shown;
[0037] FIG. **8** is a schematic top view of the heat exchanger shown in FIG. **7**;
[0038] FIG. **9** is a schematic perspective view of a heat exchanger according to an embodiment of the present disclosure, in which only several fins and several heat exchange tubes are shown;
[0039] FIG. **10** is a schematic top view of the heat exchanger shown in FIG. **9**;
[0040] FIG. **11** is a schematic enlarged view of a part C of the heat exchanger shown in FIG. **10**;
[0041] FIG. **12** is a schematic perspective view of a heat exchanger according to an embodiment of the present disclosure, in which only several fins and several heat exchange tubes are shown;
[0042] FIG. **13** is a schematic top view of the heat exchanger shown in FIG. **12**; and
[0043] FIG. **14** is an enlarged schematic view of a part D of the heat exchanger shown in FIG. **13**.
DETAILED DESCRIPTION

[0044] The present disclosure will be further explained in conjunction with the accompanying drawings and specific embodiments.
[0045] Referring to FIGS. **1** to **14**, the heat exchanger **100** according to embodiments of the present disclosure comprises: a plurality of heat exchange tubes **1** arranged in a first direction D1; and a plurality of fins **2** arranged in a second direction D2 perpendicular to the first direction D1. Each of the plurality of fins **2** comprises a fin body **20** and a plurality of heat exchange tube grooves **21** formed in the fin body **20**. At least one of the plurality of heat exchange tubes **1** is inserted into each of at least some of the plurality of heat exchange tube grooves **21**. According to some examples of the present disclosure, at least one of the plurality of heat exchange tubes **1** is inserted into each of the plurality of heat exchange tube grooves **21**. Referring to FIGS. **3** to **14**, the heat exchange tube groove **21** comprises: an open first groove end **21-1** and a second groove end **21-2** opposite to the first groove end **21-1**; and two opposite groove walls **213**, and at least one of the two groove walls **213** of at least one of the plurality of heat exchange tube grooves **21** of at least one of the plurality of fins **2** comprises a plurality of heat exchange tube guiding segments **214**. The plurality of heat exchange tube guiding segments **214** comprise: a first heat exchange tube guiding segment **214**A and a second heat exchange tube guiding segment **214**B arranged in sequence from the first groove end **21-1** to the second groove end **21-2**. As shown in FIG. **6**, a line connecting between two endpoints of the first heat exchange tube guiding segment **214**A is inclined at a first angle α1 relative to a reference plane defined by the first direction D1 and the second direction D2, and a line connecting between two endpoints of the second heat exchange tube guiding segment **214**B is inclined at a second angle α2 relative to the reference plane when viewed in a direction perpendicular to the fin body **20**, and the second angle α2 is greater than the first angle α1 and less than 90 degrees. The plurality of heat exchange tube guiding segments **214** may further comprise a third heat exchange tube guiding segment **214**C between the second heat exchange tube guiding segment **214**B and the second groove end **21-2**. As shown in FIG. **6**, a line connecting between two endpoints of the third heat exchange tube guiding segment **214**C is inclined at a third angle α3 relative to the reference plane when viewed in the direction perpendicular to the fin body **20**, and the third angle α3 is greater than the second angle α2 and less than 90 degrees.
[0046] Referring to FIGS. **3** to **14**, in the embodiment of the present disclosure, the plurality of heat exchange tube guiding segments **214** are straight line segments, circular arc segments, or a combination of straight line segments and circular arc segments when viewed in the direction perpendicular to the fin body **20**. That is, a plurality of heat exchange tube guiding segments **214** are all straight line segments or all arc segments, or a combination of straight line segments and arc segments.
[0047] Referring to FIGS. **3** to **14**, in the embodiment of the present disclosure, a width of a portion of the heat exchange tube groove **21** where the plurality of heat exchange tube guiding segments **214** are provided is configured to gradually decrease in a direction from the first groove end **21-1** to the second groove end **21-2** when viewed in the direction perpendicular to the fin body **20**. As shown in FIG. **6**, a maximum width W1, W2, W2 of each portion of the heat exchange tube groove **21** where the first heat exchange tube guiding segment **214**A, the second heat exchange tube guiding segment **214**B, and the third heat exchange tube guiding segment **214**C are provided and the width W4 of a portion of the heat exchange tube groove **21** located between the plurality of heat exchange tube guiding segments **214** and the second groove end **21-2** are configured to gradually decrease.
[0048] Referring to FIGS. **3** and **4**, in the embodiment of the present disclosure, a total size of the plurality of heat exchange tube guiding segments **214** in the direction from the first groove end **21-1** to the second groove end **21-2** is ¼ of a size (i.e., length) SL of the heat exchange tube groove **21**. At least one portion of at least one groove wall **213** of the heat exchange tube groove **21** located between the plurality of heat exchange tube guiding segments **214** and the second groove end **21-2** may be substantially perpendicular to the reference plane. The gap GM between at least one portion

of at least one groove wall **213** of the heat exchange tube groove **21** located between the plurality of heat exchange tube guiding segments **214** and the second groove end **21-2** and the heat exchange tube **1** may be less than or equal to 0.15 mm.
[0049] Referring to FIGS. **3** to **14**, in the embodiment of the present disclosure, two groove walls **213** of the heat exchange tube groove **21** are symmetrical or asymmetrical relative to a centerline of the heat exchange tube groove **21** perpendicular to the first direction D1 and the second direction D2 when viewed in the direction perpendicular to the fin body **20**. For example, two groove walls **213** are configured to have the same guiding segment **214** or different guiding segments **214**, or one of the two groove walls **213** is configured to have the guiding segment **214**.
[0050] Referring to FIGS. **3** to **14**, in the embodiment of the present disclosure, one of the two endpoints of the first heat exchange tube guiding segment **214**A that is close to the second heat exchange tube guiding segment **214**B and one of the two endpoints of the second heat exchange tube guiding segment **214**B that is close to the first heat exchange tube guiding segment **214**A are configured to substantially overlap with each other when viewed in the direction perpendicular to the fin body **20**. For example, one of the two endpoints of the first heat exchange tube guiding segment **214**A that is close to the second heat exchange tube guiding segment **214**B and one of the two endpoints of the second heat exchange tube guiding segment **214**B that is close to the first heat exchange tube guiding segment **214**A are configured to substantially overlap with each other, and one of the two endpoints of the second heat exchange tube guiding segment **214**B that is close to the third heat exchange tube guiding segment **214**C and one of the two endpoints of the third heat exchange tube guiding segment **214**C that is close to the second heat exchange tube guiding segment **214**B are configured to substantially overlap with each other when viewed in the direction perpendicular to the fin body **20**. The first heat exchange tube guiding segment **214**A and the third heat exchange tube guiding segment **214**C may be straight line segments, and the second heat exchange tube guiding segment **214**B may be a circular arc segment when viewed in the direction perpendicular to the fin body **20**. For example, other suitable straight or circular segments may also be comprised between adjacent heat exchange tube guiding segments.
[0051] Referring to FIG. **1**, FIG. **7**, and FIG. **8**, in the embodiment of the present disclosure, the plurality of heat exchange tubes **1** comprise a plurality of rows of heat exchange tubes arranged in the first direction D1, and each row of heat exchange tubes is consisted of one heat exchange tube **1** or a plurality of heat exchange tubes **1**. The one heat exchange tube **1** or the plurality of heat exchange tubes **1** of each of the plurality of rows of heat exchange tubes are inserted into one of the plurality of heat exchange tube grooves **21**. And a length of at least one of the plurality of heat exchange tube grooves **21** of at least one of the plurality of fins **2** in a third direction D3 perpendicular to the first direction D1 and the second direction D2 is greater than a heat exchange tube size of a row of heat exchange tubes inserted therein in the third direction D3, in the case where the row of heat exchange tubes is consisted of one heat exchange tube **1**, the heat exchange tube size is a size of said one heat exchange tube **1** in the third direction D3, while in the case where the row of heat exchange tubes is consisted of a plurality of heat exchange tubes **1**, the heat exchange tube size is a sum of the sizes of the plurality of heat exchange tubes **1** in the third direction D3. Thereby, a gap **5** may be formed in the heat exchange tube grooves **21** for water to pass through. For example, the gap **5** forms a drainage channel through which defrosting water may quickly flow away, thereby improving a performance of the heat exchanger under frosting conditions.
[0052] Referring to FIGS. **1**, **7** and **8**, in the embodiments of the present disclosure, the plurality of heat exchange tube grooves **21** comprise a plurality of columns of heat exchange tube grooves arranged in the third direction perpendicular to the first direction D1 and the second direction D2. Each of the plurality of columns of heat exchange tube grooves comprises a plurality of heat exchange tube grooves **21** arranged in the first direction D1. FIGS. **7** and **8** show a first column of heat exchange tube grooves comprising a plurality of heat exchange tube grooves **21**A and a second

column of heat exchange tube grooves comprising a plurality of heat exchange tube grooves **21**B. The first column of heat exchange tube grooves and the second column of heat exchange tube grooves are respectively located on a first side S1 and a second side S2 of the heat exchanger **100** opposite to each other in the third direction D3. In addition, the fin **2** may comprise three or more columns of heat exchange tube grooves. The fin body **20** of the fin **2** may have a generally flat plate shape. At least two of the heat exchange tube grooves **21** in the plurality of columns of heat exchange tube grooves of at least one of the plurality of fins **2** may have different lengths in the third direction D3. In some embodiments of the present disclosure, at least two of the plurality of heat exchange tube grooves **21** in at least one of the plurality of columns of heat exchange tube grooves **21** of at least one of a plurality of fins **2** have different lengths in the third direction D3. In some embodiments of the present disclosure, at least two of a plurality of heat exchange tube grooves **21** in at least one of a plurality of columns of heat exchange tube grooves of at least one of a plurality of fins **2** have different lengths in the third direction D3. In some other embodiments of the present disclosure, at least one of a plurality of heat exchange tube grooves **21** in at least one of a plurality of columns of heat exchange tube grooves **21** of a plurality of fins **2** and at least one of a plurality of heat exchange tube grooves **21** in at least another one of a plurality of columns of heat exchange tube grooves **21** of a plurality of fins **2** have different lengths in the third direction D3. For example, at least one of a plurality of heat exchange tube groove **21** in at least one of a plurality of columns of heat exchange tube grooves located on the first side S1 of the heat exchanger **100** in the third direction D3 of at least one of a plurality of fins **2**, and at least one of a plurality of heat exchange tube groove **21** in at least another one of a plurality of columns of heat exchange tube grooves located on the second side S2 of the heat exchanger **100** opposite to the first side S1 in the third direction D3 of at least one of a plurality of fins **2** have different lengths in the third direction D3. For example, the length of at least one of a plurality of heat exchange tube groove **21** in at least one of a plurality of columns of heat exchange tube grooves located on the first side S1 of the heat exchanger **100** in the third direction D3 of at least one of a plurality of fins **2** in the third direction D3 is less than the length of at least one of a plurality of heat exchange tube groove **21** in at least another one of a plurality of columns of heat exchange tube grooves located on the second side S2 of the heat exchanger **100** opposite to the first side S1 in the third direction D3 of at least one of a plurality of fins **2** in the third direction D3.

[0053] Referring to FIGS. **1**, **7** and **8**, in an embodiment of the present disclosure, a plurality of heat exchange tube grooves **21** in at least one of a plurality of columns of heat exchange tube grooves of a plurality of fins **2** and a plurality of heat exchange tube grooves **21** in at least another one of a plurality of columns of heat exchange tube grooves of a plurality of fins may be alternately arranged in the first direction D1. The heat exchange tube groove **21** in columns of heat exchange tube grooves of the fins **2** is configured to have a first groove edge **211** and a second groove edge **212**. The first groove edge **211** and the second groove edge **212** are located at the outermost side of the heat exchange tube groove **21** in the third direction D3, and in the third direction D3, the first groove edge **211** of the heat exchange tube groove **21** of the fin **2** is closer to the first side S1 of the heat exchanger **100** in the third direction D3 than the second groove edge **212** of the heat exchange tube groove **21** of the fin **2**. The first groove edges **211** of a plurality of heat exchange tube groove **21** in at least one of a plurality of columns of heat exchange tube grooves of a plurality of fins **2** may be substantially aligned with each other in the third direction D3, and/or the second groove edges **212** of a plurality of heat exchange tube grooves **21** in at least one of a plurality of columns of heat exchange tube grooves of a plurality of fins **2** may be substantially aligned with each other in the third direction D3. A plurality of heat exchange tube grooves **21** in at least one of a plurality of columns of heat exchange tube grooves of a plurality of fins **2** may have substantially the same size in the third direction D3.

[0054] Referring to FIGS. **1**, **7** and **8**, in the embodiments of the present disclosure, a plurality of heat exchange tube grooves **21** located on the first side S1 of the heat exchanger **100** in the third direction D3 in at least one of a plurality of columns of heat exchange tube grooves of at least one of a plurality of fins **2** and a plurality of heat exchange tube grooves **21** located on the second side S2 of the heat exchanger **100** opposite to the first side S1 in the third direction D3 in at least another one of a plurality of columns of heat exchange tube grooves of at least one of a plurality of fins **2** are alternately arranged in the first direction D1. According to an example of the present disclosure, at least one of a plurality of heat exchange tube grooves **21** located on the first side S1 of the heat exchanger **100** in the third direction D3 in at least one of a plurality of columns of heat exchange tube grooves of a plurality of fins **2** and at least one of a plurality of heat exchange tube grooves **21** located on the second side S2 of the heat exchanger **100** opposite to the first side S1 in the third direction D3 in at least another one of a plurality of columns of heat exchange tube grooves of a plurality of fins **2** are offset from each other in the first direction D1.

[0055] Referring to FIGS. **1**, **7** and **8**, in an embodiment of the present disclosure, a plurality of columns of heat exchange tube grooves of a plurality of fins **2** comprise first and second columns of heat exchange tube grooves respectively located on the first side S1 and second side S2 of the heat exchanger **100** opposite to each other in the third direction D3. The plurality of heat exchange tube grooves **21**A in the first column of heat exchange tube grooves of a plurality of fins **2** are configured to open towards the first side S1 of the heat exchanger **100**, and the plurality of heat exchange tube grooves **21**B in the second column of heat exchange tube grooves of a plurality of fins **2** are configured to open towards the second side S2 of the heat exchanger **100**.

[0056] Referring to FIGS. **1**, **7** and **8**, in an embodiment of the present disclosure, the second groove edges **212** of at least two of the plurality of heat exchange tube grooves **21**A in the first column of heat exchange tube grooves of a plurality of fins **2** are offset from each other in the third direction D3, and/or the first groove edges **211** of at least two of the plurality of heat exchange tube grooves **21**B in the second column of heat exchange tube grooves of a plurality of fins **2** are offset from each other in the third direction D3. At least one of the plurality of heat exchange tube grooves **21**A in the first column of heat exchange tube grooves of a plurality of fins **2** and at least one of the plurality of heat exchange tube grooves **21**B in the second column of heat exchange tube grooves of a plurality of fins **2** are offset from each other in the first direction D1. At least one of the plurality of heat exchange tube grooves **21**A in the first column of heat exchange tube grooves of a plurality of fins **2** may be substantially aligned with at least one of the plurality of heat exchange tube grooves **21**B in the second column of heat exchange tube grooves of a plurality of fins **2** in the first direction D1. According to the embodiments of the present disclosure, by offsetting the groove edges of the heat exchange tube grooves in the third direction D3 and offsetting the heat exchange tube grooves in the first direction D1, a flow path for discharging a condensate water may be shortened, which is conducive to rapidly discharge the condensate water, reduce the windage resistance, and adjust an amount of the condensed condensate water.

[0057] Referring to FIGS. **1**, **7** and **8**, in an embodiment of the present disclosure, the length of at least one of a plurality of heat exchange tube groove **21**A in the first column of heat exchange tube grooves of at least one of a plurality of fin **2** in the third direction D3 is greater than the heat exchange tube size of the row of the heat exchange tubes inserted therein in the third direction D3, and/or the length of at least one of a plurality of heat exchange tube groove **21**B in the second column of heat exchange tube grooves of at least one of a plurality of fin **2** in the third direction D3 is greater than the heat exchange tube size of the row of the heat exchange tubes inserted therein in the third direction D3. In an embodiment of the present disclosure, the length of at least one of a plurality of heat exchange tube groove **21**A in the first column of heat exchange tube grooves of at least one of a plurality of fin **2** in the third direction D3 is substantially equal to the heat exchange tube size of the row of the heat exchange tubes inserted therein in the third direction D3, and/or the length of at least one of a plurality of heat exchange tube groove **21**B in the second column of heat exchange tube grooves of at least one of a plurality of fin **2** in the third direction D3 is substantially equal to the heat exchange tube size of the row of the heat exchange tubes inserted therein in the

third direction D3.
[0058] Referring to FIGS. **1**, **7** and **8**, in an embodiment of the present disclosure, the heat exchange tubes **1** in the rows of the heat exchange tubes disposed in the plurality of heat exchange tube grooves **21** or in a plurality of columns of heat exchange tube grooves of the plurality of fins **2** comprise a plurality of columns of heat exchange tubes arranged in the third direction D3, and each of the plurality of columns of heat exchange tubes comprises a plurality of heat exchange tubes **1** arranged in the first direction D1. For example, the first column of heat exchange tubes comprise a plurality of heat exchange tubes **1**A, the second column of heat exchange tubes comprise a plurality of heat exchange tubes **1**B, the third column of heat exchange tubes comprise a plurality of heat exchange tubes **1**C, the fourth column of heat exchange tubes comprise a plurality of heat exchange tubes **1**D, and so on. Referring to FIGS. **1** and **2**, in an embodiment of the present disclosure, a heat exchange tube **1** in the plurality of columns of heat exchange tubes **1** comprises a first end **18** located on one side of the heat exchange tube in the second direction D2 and a second end **19** located on the other side of the heat exchange tube **1** in the second direction D2.
[0059] In one example, the heat exchanger **100** further comprises a first collecting tube connected to and in fluid communication with the first ends **18** of the heat exchange tubes **1**; and a second collecting tube connected to and in fluid communication with the second ends **19** of heat exchange tubes **1**.
[0060] In another example, the heat exchanger **100** further comprises a first collecting tube connected to and in fluid communication with the first ends **18** of the heat exchange tubes **1** in a plurality of columns of heat exchange tubes; and two second collecting tubes, one of which is connected to and in fluid communication with the second ends **19** of the heat exchange tubes **1** in at least one of a plurality of columns of heat exchange tubes, and the other of the two second collecting tubes is connected to and in fluid communication with the second ends **19** of the heat exchange tubes **1** in at least another one of a plurality of columns of heat exchange tubes.
[0061] In another example, referring to FIGS. **1** and **2**, the heat exchanger **100** further comprises a connecting portion **6**, through which the first end **18** of the heat exchange tube **1** in one of the plurality of columns of heat exchange tubes is connected to and in fluid communication with the first ends **18** of the heat exchange tubes **1** in another one of the plurality of columns of heat exchange tubes; and two second collecting tubes **32**, one of which is connected to and in fluid communication with a second ends **19** of the heat exchange tubes **1** in the one column of heat exchange tubes, and the other of which is connected to and in fluid communication with a second ends **19** of the heat exchange tubes **1** in the another column of heat exchange tubes. The connecting portion **6** may be a plurality of connecting pipes **60**, through which a first ends **18** of the heat exchange tubes **1** in the one column of heat exchange tubes are connected to and in fluid communication with a first ends **18** of the heat exchange tubes **1** in the another column of heat exchange tubes. The connecting portion **6** may also make the first ends **18** of the heat exchange tubes **1** in the one column of heat exchange tubes connected to and being in fluid communication with the first ends **18** of the heat exchange tubes **1** in the another one column of heat exchange tubes, instead of making the first ends **18** of the heat exchange tubes **1** in the one column of heat exchange tubes connected to and being in fluid communication with the first ends **18** of the heat exchange tubes **1** in the another one column of heat exchange tubes via one-to-one correspondence. The heat exchange tubes **1** in one column of heat exchange tubes, the connecting tubes **60**, and the heat exchange tubes **1** in another column of heat exchange tubes that are interconnected with one another may be formed by a single bent tube. In the example shown in FIGS. **1** and **2**, the first ends **18** of the heat exchange tubes **1** in two of a plurality of columns of heat exchange tubes are connected to and in fluid communication with the first ends **18** of the heat exchange tubes **1** in another two of a plurality of columns of heat exchange tubes. One of the two second collecting tubes **32** is connected to and in fluid communication with the second ends **19** of the heat exchange tubes **1** in two columns of the heat exchange tubes, and the other one of the two second collecting

tubes **32** is connected to and in fluid communication with the second ends **19** of the heat exchange tubes **1** in the other two columns of the heat exchange tubes. More specifically, the plurality of columns of heat exchange tubes comprise a first column of heat exchange tubes (comprising the heat exchange tubes **1**A), a second column of heat exchange tubes (comprising the heat exchange tubes **1**B), a third column of heat exchange tubes (comprising the heat exchange tubes **1**C), and a fourth column of heat exchange tubes (comprising the heat exchange tubes **1**D) arranged in sequence in the first direction D1. The heat exchanger **100** further comprises a first connecting portion **6**A and a second connecting portion **6**B, wherein the first ends **18** of the heat exchange tubes **1**A in the first column of heat exchange tubes are connected to and in fluid communication with the first ends **18** of the heat exchange tubes **1**C in the third column of heat exchange tubes through the first connecting portion **6**A, and the first ends **18** of the heat exchange tubes **1**B in the second column of heat exchange tubes are connected to and in fluid communication with the first ends **18** of the heat exchange tubes **1**D in the fourth column of heat exchange tubes through the second connecting portion **6**B; and two second collecting tubes **32**, one of which is connected to and in fluid communication with the second ends **19** of the heat exchange tubes **1**A in the first column of heat exchange tubes and the heat exchange tubes **1**B in the second column of heat exchange tubes, and the other of which is connected to and in fluid communication with the second ends **19** of the heat exchange tubes **1**C in the third column of heat exchange tubes and the heat exchange tubes **1**D in the fourth column of heat exchange tubes. For example, the first connecting portion **6**A comprises a plurality of first connecting tubes **60**A, through which the first ends **18** of the heat exchange tubes **1**A in the first column of heat exchange tubes are connected to and in fluid communication with the first ends **18** of the heat exchange tubes **1**C in the third column of heat exchange tubes respectively; and the second connecting portion **6**B may comprise for example a plurality of second connecting tubes **60**B, through which the first ends **18** of the heat exchange tubes **1**B in the second column of heat exchange tubes are connected to and in fluid communication with the first ends **18** of the heat exchange tube **1**D in the fourth column of heat exchange tubes respectively. The heat exchange tubes **1**A in the first column of heat exchange tubes, the first connecting tubes **60**A, and the heat exchange tubes **1**C in the third column of heat exchange tubes that are interconnected with one another may be formed by a single bent tube; and the heat exchange tubes **1**B in the second column of heat exchange tubes, the second connecting tubes **60**B, and the heat exchange tubes **1**D in the fourth column of heat exchange tubes that are interconnected with one another may be formed by a single bent tube.

[0062] In a further example, the heat exchanger **100** further comprises two first collecting tubes and two second collecting tubes, one of the two first collecting tubes and one of the two second collecting tubes being respectively connected to and in fluid communication with the first ends **18** and the second ends **19** of the heat exchange tubes **1** in at least one of a plurality of columns of the heat exchange tubes, and the other one of the two first collecting tubes and the other one of the two second collecting tubes being respectively connected to and in fluid communication with the first ends **18** and the second ends **19** of the heat exchange tubes **1** in at least another one of the plurality of columns of the heat exchange tubes.

[0063] Referring to FIGS. **1** and **2**, in an embodiment of the present disclosure, at least one portion of the heat exchange tube **1** is configured to extend substantially vertically during use. For example, the heat exchange tube **1** is configured to extend substantially vertically. In addition, at least one portion of the heat exchange tube **1** may also extend substantially horizontally or obliquely, for example, heat exchange tube **1** may extend substantially horizontally or obliquely. In an embodiment of the present disclosure, each of at least some of the fins **2** is formed by a single plate. For example, the fin **2** is formed by a single plate. The fin body **20** of the fin **2** may be inclined relative to the plane defined by the first direction D1 and the third direction D3. The angle between the fin body **20** of the fin **2** and the plane defined by the first direction D1 and the third direction D3 may be less than or equal to 45 degrees. When the heat exchanger is used as an evaporator, condensate water is generated, and tilting the fin body **20** of the fin **2** would facilitate to smoothly discharge the condensate water and reduce the windage resistance.

[0064] In the examples shown in FIGS. **7** and **8**, a plurality of heat exchange tube grooves **21**A in the first column of heat exchange tube grooves are configured to open towards the first side S1 of heat exchanger **100**, and a plurality of heat exchange tube grooves **21**B in the second column of heat exchange tube grooves are configured to open towards the second side S2 of heat exchanger **100**. The columns of heat exchange tube grooves comprise heat exchange tube grooves **21** of different lengths. The plurality of heat exchange tube grooves **21**A in the first column of heat exchange tube grooves and the plurality of heat exchange tube grooves **21**B in the second column of heat exchange tube grooves are offset from each other in the first direction D1. The spacing between the plurality of heat exchange tube grooves **21**A in the first column of heat exchange tube grooves is substantially the same as the spacing between the plurality of heat exchange tube grooves **21**B in the second column of heat exchange tube grooves. The heat exchange tubes **1** are configured to have the same size (i.e. width Tw) in the third direction D3. The length SL of some heat exchange tube grooves **21** is greater than the size of the heat exchange tubes inserted therein in the third direction D3 (i.e. width Tw), and the length SL of some heat exchange tube grooves **21** is equal to the size of the heat exchange tubes inserted therein in the third direction D3 (i.e. width Tw). At least one of the plurality of heat exchange tube grooves **21**A in the first column of heat exchange tube grooves of a plurality of fins **2** and at least one of the plurality of heat exchange tube grooves **21**B in the second column of heat exchange tube grooves of the plurality of fins **2** are offset from each other in the first direction D1. Correspondingly, the heat exchange tube **1** in at least one of a plurality of heat exchange tube grooves **21**A in the first column of heat exchange tube grooves of the plurality of fins **2** and the heat exchange tube **1** in at least one of a plurality of heat exchange tube grooves **21**B in the second column of heat exchange tube grooves of the plurality of fins **2** are offset from each other in the first direction D1.

[0065] In an embodiment of the present disclosure, the heat exchange tube body **10** of the heat exchange tube **1** may be a flat tube or any heat exchange tube having two planes generally parallel with each other.

[0066] In the embodiment shown in FIGS. **7** and **8**, the length SL of some of the plurality of the heat exchange tube grooves **21** of the plurality of fins **2** in the third direction D3 is greater than the heat exchange tube size of the row of the heat exchange tubes inserted therein in the third direction D3 or greater than the size of the heat exchange tubes **1** inserted therein in the third direction D3 (i.e., width Tw), while the length SL of some other of the plurality of the heat exchange tube grooves **21** of the plurality of fins **2** in the third direction D3 is equal to the heat exchange tube size of the row of the heat exchange tubes inserted therein in the third direction D3 or equal to the size of the heat exchange tubes **1** inserted therein in the third direction D3 (i.e., width Tw).

[0067] The air conditioning system according to an embodiment of the present disclosure comprises the heat exchanger **100** as described above. More specifically, the air conditioning system comprises: a compressor, a condenser, an evaporator, an expansion valve and so on. At least one of the condenser and evaporator may be the aforementioned heat exchanger **100**.

[0068] By using the heat exchanger according to the embodiments of the present disclosure and the air conditioning system comprising the heat exchanger, for example, the performance of the heat exchanger and the air conditioning system may be improved.

[0069] According to an embodiment of the present disclosure, referring to FIG. **3** to FIG. **6**, a plurality of heat exchange tube guiding segments **214** with different angles relative to the centerline of the heat exchange tube groove **21** are used, and the angle gradually transitions from a large value to a small value, and a width of the portion of the heat exchange tube groove **21** where a plurality of heat exchange tube guiding segments **214** are provided is configured to gradually decrease in the direction from the first groove end **21-1** to the second groove end **21-2**. The flat tube is gradually inserted into the portion of the heat exchange tube groove **21** located between the plurality of heat exchange tube guiding segments **214** and the second groove end **21-2**.

[0070] According to an embodiment of the present disclosure, referring to FIG. **3** to FIG. **6**, a plurality of heat exchange tube guiding segments **214** that are inclined at different angles relative to the reference plane defined by the first direction D1 and the second direction D2 are used. An opening angle (90 degrees-α1) of the first heat exchange tube guiding segment **214**A is relatively large, and a maximum width W1 of the portion of the heat exchange tube groove **21** where the first heat exchange tube guiding segment **214**A is provided is relatively large. The first angle α1, the second angle α2, and the third angle α3 of the first heat exchange tube guiding segment **214**A, the second heat exchange tube guiding segment **214**B, and the third heat exchange tube guiding segment **214**C are configured to gradually increase, and the maximum widths W1, W2, and W2 of the portions of the heat exchange tube groove **21** where the first heat exchange tube guiding segment **214**A, the second heat exchange tube guiding segment **214**B, and the third heat exchange tube guiding segment **214**C are provided and the width W4 of the portion of the heat exchange tube groove **21** located between a plurality of heat exchange tube guiding segments **214** and the second groove end **21-2** are configured to gradually decrease. The heat exchange tube is initially guided in the first heat exchange tube guiding segment **214**A when it is inserted. As the heat exchange tube enters the portion of the heat exchange tube groove **21** where the first heat exchange tube guiding segment **214**A is provided, the relative positions between the fins and the heat exchange tubes will also be initially adjusted into a relatively small range. Then, the heat exchange tube will continue to enter the heat exchange tube groove due to the guidance of the portion of the heat exchange tube groove **21** where the second heat exchange tube guiding segment **214**B is provided, the opening angle (90 degrees-α2) of the second heat exchange tube guiding segment **214**B is smaller than the opening angle of the first heat exchange tube guiding segment **214**A (90 degrees-α1), and the width of the portion of the heat exchange tube groove **21** where the second heat exchange tube guiding segment **214**B is provided is smaller than that of the portion of the heat exchange tube groove **21** where the first heat exchange tube guiding segment **214**A is provided, thus the relative positions between the heat exchange tubes and the heat exchange tube grooves will be further reduced. Correspondingly, the heat exchange tube will be gradually guided by the subsequent heat exchange tube guiding segment to the main heat exchange tube groove area. Due to the opening angles of the first heat exchange tube guiding segment **214**A, the second heat exchange tube guiding segment **214**B, and the third heat exchange tube guiding segment **214**C, and the gradual transition of the widths of each of the portions of the heat exchange tube groove **21** where the first heat exchange tube guiding segment **214**A, the second heat exchange tube guiding segment **214**B, and the third heat exchange tube guiding segment **214**C are provided, the heat exchange tubes will not be stuck in local positions. In addition, as shown in FIG. **4**, the gap GM between at least one portion of at least one groove wall **213** of the heat exchange tube groove **21** located between a plurality of heat exchange tube guiding segments **214** and the second groove end **21-2** and the heat exchange tube **1** may be less than or equal to 0.15 mm. The distance between the groove wall **213** of heat exchange tube groove **21** and the surface of the nearest heat exchange tube **1** is GM, which is less than or equal to 0.15 mm. Thus, effective welding of the heat exchange tubes and fins may be ensured, reducing a waste of a heat exchange area of the fins.

[0071] According to an embodiment of the present disclosure, referring to FIG. **3** to FIG. **6**, a plurality of heat exchange tube guiding segments **214** comprise: a first heat exchange tube guiding segment **214**A, a second heat exchange tube guiding segment **214**B, and a third heat exchange tube guiding segment **214**C. The first angle α1 is less than the second angle α2, which is less than the third angle α3. The opening angles 90-α1, 90-α2, and 90-α3 of the first heat exchange tube guiding segment **214**A, the second heat exchange tube guiding segment **214**B, and the third heat exchange tube guiding segment **214**C are configured to gradually decrease. The maximum widths W1, W2, and W3 of respective portions of the heat exchange tube groove **21** where the first, second, and third heat exchange tube guiding segments **214**A, **214**B, and **214**C are provided, and the width W4 of the portion of the heat exchange tube groove **21** located between the plurality of heat exchange tube guiding segments **214** and the second groove end **21-2** are configured to gradually decrease (W1>W2>W3>W4). The total size of the plurality of heat exchange tube guiding segments **214** in the direction from the first groove end **21-1** to the second groove end **21-2** is ¼ of the size (length) SL of the heat exchange tube groove **21**. The gap GM between the portion of the groove wall **213** of the heat exchange tube groove **21** located between the plurality of heat exchange tube guiding segments **214** and the second groove end **21-2** and the surface of the heat exchange tube **1** is less than or equal to 0.15 mm.

[0072] According to an embodiment of the present disclosure, referring to FIG. **9** to FIG. **11**, at least one of the plurality of heat exchange tube guiding segments **214** is a circular arc segment. For example, the first heat exchange tube guiding segment **214**A and the third heat exchange tube guiding segment **214**C may be straight line segments, and the second heat exchange tube guiding segment **214**B may be a circular arc segment. If a plurality of heat exchange tube guiding segments **214** are straight line segments, the sharp corners at the intersections of the two heat exchange tube guiding segments **214** may scratch the surface of the heat exchange tubes during the guiding process, leading to potential quality issues. The circular arc segments will reduce the sharp parts, making the guidance much smoother and reducing the risk of damage to the heat exchange tube.

[0073] According to an embodiment of the present disclosure, referring to FIG. **12** to FIG. **14**, one of the two groove walls **213** comprises a plurality of heat exchange tube guiding segments **214**, while the other one of the two groove walls **213** does not have the heat exchange tube guiding segment **214** and is perpendicular to the reference plane defined by the first direction D1 and the second direction D2. The two groove walls **213** are not completely symmetrical.

[0074] According to an embodiment of the present disclosure, by setting a plurality of heat exchange tube guiding segments **214**, the higher efficiency may be achieved during the assembly process of the product. In addition, due to the guiding effect of the plurality of heat exchange tube guiding segments **214**, the damage to the fin ends is reduced during the process of the insertion of heat exchange tubes into the heat exchange tube grooves, thus the yield is improved. A specified size is set between the heat exchange tube guiding segments **214** and the surface of the heat exchange tubes, thereby increasing a welding fit ratio between the fins and the heat exchange tube. The welding fit area between the fins and the heat exchange tubes is larger and more sufficient, thereby reducing ineffective fins or the waste of the heat exchange area of heat exchange tubes.

[0075] According to an embodiment of the present disclosure, the plurality of heat exchange tube guiding segments **214** may comprise two, four, or more heat exchange tube guiding segments, and the corresponding endpoints of adjacent heat exchange tube guiding segments may overlap with or be spaced apart from each other, as long as the guiding function is achieved.

[0076] Although the above embodiments have been described, some features of the above embodiments and/or some embodiments of the above embodiments may be combined to form new embodiments.

[0077] While the present disclosure has been illustrated and described with respect to a particular embodiment thereof, it should be appreciated by those of ordinary skill in the art that various modifications to this disclosure may be made without departing from the spirit and scope of the present disclosure.

Claims

1. A heat exchanger comprising: a plurality of heat exchange tubes arranged in a first direction; and a plurality of fins arranged in a second direction perpendicular to the first direction, each of which comprises a fin body and a plurality of heat exchange tube grooves formed in the fin body, with at least one of the plurality of heat exchange tubes being inserted into each of at least some of the plurality of heat exchange tube grooves, wherein the heat exchange tube groove comprises: an open first groove end and a second groove end opposite to the first groove end; and two opposite groove walls, and at least one of the two groove walls of at least one of the plurality of heat exchange tube grooves of at least one of the plurality of fins comprises a plurality of heat exchange tube guiding segments comprising: a first heat exchange tube guiding segment and a second heat exchange tube guiding segment arranged in sequence from the first groove end to the second groove end, wherein, a line connecting between two endpoints of the first heat exchange tube guiding segment is inclined at a first angle relative to a reference plane defined by the first and second directions, and a line connecting between two endpoints of the second heat exchange tube guiding segment is inclined at a second angle relative to the reference plane when viewed in a direction perpendicular to the fin body, and the second angle is greater than the first angle and less than 90 degrees.

2. The heat exchanger according to claim 1, wherein the plurality of heat exchange tube guiding segments further comprise a third heat exchange tube guiding segment between the second heat exchange tube guiding segment and the second groove end, a line connecting between two endpoints of the third heat exchange tube guiding segment is inclined at a third angle relative to the reference plane when viewed in the direction perpendicular to the fin body, and the third angle is greater than the second angle and less than 90 degrees.

3. The heat exchanger according to claim 1, wherein the plurality of heat exchange tubes comprise a plurality of rows of heat exchange tubes arranged in the first direction, each row of heat exchange tubes consisting of one heat exchange tube or a plurality of heat exchange tubes; the one heat exchange tube or the plurality of heat exchange tubes of each of the plurality of rows of heat exchange tubes are inserted into one of the plurality of heat exchange tube grooves; and the length of at least one of the plurality of heat exchange tube grooves of at least one of the plurality of fins in a third direction perpendicular to the first and second directions is greater than a heat exchange tube size of a row of heat exchange tubes inserted therein in the third direction, in the case where the row of heat exchange tubes is consisted of one heat exchange tube, the heat exchange tube size is the size of that one heat exchange tube in the third direction, while in the case where the row of heat exchange tubes is consisted of a plurality of heat exchange tubes, the heat exchange tube size is a sum of the sizes of the plurality of heat exchange tubes in the third direction.

4. The heat exchanger according to claim 3, wherein the heat exchange tubes in the rows of the heat exchange tubes disposed in the plurality of heat exchange tube grooves of the plurality of fins comprise a plurality of columns of heat exchange tubes arranged in the third direction, and each of the plurality of columns of heat exchange tubes comprises a plurality of heat exchange tubes arranged in the first direction.

5. The heat exchanger according to claim 4, wherein a heat exchange tube in a plurality of columns of heat exchange tubes comprises a first end located on one side of the heat exchange tube in the second direction and a second end located on the other side of the heat exchange tube in the second direction; and the heat exchanger further comprises a connecting portion, through which the first ends of the heat exchange tubes in one of the plurality of columns of heat exchange tubes are connected to and in fluid communication with the first ends of the heat exchange tubes in another one of the plurality of columns of heat exchange tubes respectively; and two second collecting tubes, one of which is connected to and in fluid communication with the second ends of the heat exchange tubes in one column of heat exchange tubes, and the other of which is connected to and in fluid communication with the second ends of the heat exchange tubes in another column of heat exchange tubes respectively.

6. The heat exchanger according to claim 5, wherein the connecting portion comprises a plurality of connecting tubes, through which the first ends of the heat exchange tubes in the one column of heat exchange tubes are connected to and in fluid communication with the first ends of the heat exchange tubes in the another column of heat exchange tubes respectively.

7. The heat exchanger according to claim 6, wherein the heat exchange tubes in the one column of heat exchange tubes, the connecting tubes, and the heat exchange tubes in the another column of

heat exchange tubes that are interconnected with one another are formed by a single bent tube.
8. The heat exchanger according to claim 4, wherein the heat exchange tube in a plurality of columns of heat exchange tubes comprise a first end located on one side of the heat exchange tube in the second direction and a second end located on the other side of the heat exchange tube in the second direction; the plurality of columns of heat exchange tubes comprise a first column of heat exchange tubes, a second column of heat exchange tubes, a third column of heat exchange tubes, and a fourth column of heat exchange tubes arranged in sequence in the first direction; the heat exchanger further comprises a first connecting portion and a second connecting portion, wherein the first ends of the heat exchange tubes in the first column of heat exchange tubes are connected to and in fluid communication with the first ends of the heat exchange tubes in the third column of heat exchange tubes through the first connecting portion respectively, and the first ends of the heat exchange tubes in the second column of heat exchange tubes are connected to and in fluid communication with the first ends of the heat exchange tubes in the fourth column of heat exchange tubes through the second connecting portion respectively; and two second collecting tubes, one of which is connected to and in fluid communication with the second ends of the heat exchange tubes in the first column of heat exchange tubes and the second column of heat exchange tubes respectively, and the other of which is connected to and in fluid communication with the second ends of the heat exchange tubes in the third column of heat exchange tubes and the fourth column of heat exchange tubes respectively.
9. The heat exchanger according to claim 8, wherein the first connecting portion comprises a plurality of first connecting tubes, through which the first ends of the heat exchange tubes in the first column of heat exchange tubes are connected to and in fluid communication with the first ends of the heat exchange tubes in the third column of heat exchange tubes respectively; and the second connecting portion comprises a plurality of second connecting tubes, through which the first ends of the heat exchange tubes in the second column of heat exchange tubes are connected to and in fluid communication with the first ends of the heat exchange tubes in the fourth column of heat exchange tubes respectively.
10. The heat exchanger according to claim 9, wherein the heat exchange tubes in the first column of heat exchange tubes, the first connecting tubes, and the heat exchange tubes in the third column of heat exchange tubes that are interconnected with one another are formed by a single bent tube; and the heat exchange tubes in the second column of heat exchange tubes, the second connecting tubes, and the heat exchange tubes in the fourth column of heat exchange tubes that are interconnected with one another are formed by a single bent tube.
11. The heat exchanger according to claim 1, wherein the plurality of heat exchange tube grooves comprise a plurality of columns of the heat exchange tube grooves arranged in a third direction perpendicular to the first and second directions, each of the plurality of columns of the heat exchange tube grooves comprising a plurality of heat exchange tube grooves arranged in the first direction.
12. The heat exchanger according to claim 11, wherein at least two of a plurality of heat exchange tube grooves in at least one of a plurality of columns of heat exchange tube grooves of the plurality of fins have different lengths in the third direction.
13. The heat exchanger according to claim 11, wherein a plurality of heat exchange tube grooves in at least one of a plurality of columns of heat exchange tube grooves of the plurality of fins and a plurality of heat exchange tube grooves in at least another one of a plurality of columns of heat exchange tube grooves of the plurality of fins are alternately arranged in the first direction.
14. The heat exchanger according to claim 1, wherein the width of the portion of the heat exchange tube groove where the plurality of heat exchange tube guiding segments are provided is configured to gradually decrease in a direction from the first groove end to the second groove end when viewed in the direction perpendicular to the fin body.
15. The heat exchanger according to claim 1, wherein the plurality of heat exchange tube guiding

segments are straight line segments, circular arc segments, or a combination of the straight line segments and circular arc segments when viewed in the direction perpendicular to the fin body.

16. (canceled)

17. (canceled)

18. The heat exchanger according to claim 1, wherein a gap between at least one portion of at least one groove wall of the heat exchange tube groove located between the plurality of heat exchange tube guiding segments and the second groove end and the heat exchange tube is less than or equal to 0.15 mm.

19. (canceled)

20. The heat exchanger according to claim 1, wherein one of the two endpoints of the first heat exchange tube guiding segment that is close to the second heat exchange tube guiding segment and one of the two endpoints of the second heat exchange tube guiding segment that is close to the first heat exchange tube guiding segment are configured to substantially overlap with each other when viewed in the direction perpendicular to the fin body.

21. The heat exchanger according to claim 2, wherein one of the two endpoints of the first heat exchange tube guiding segment that is close to the second heat exchange tube guiding segment and one of the two endpoints of the second heat exchange tube guiding segment that is close to the first heat exchange tube guiding segment are configured to substantially overlap with each other, and one of the two endpoints of the second heat exchange tube guiding segment that is close to the third heat exchange tube guiding segment and one of the two endpoints of the third heat exchange tube guiding segment that is close to the second heat exchange tube guiding segment are configured to substantially overlap with each other when viewed in the direction perpendicular to the fin body.

22. The heat exchanger according to claim 21, wherein the first heat exchange tube guiding segment and the third heat exchange tube guiding segment are straight line segments, and the second heat exchange tube guiding segment is a circular arc segment when viewed in the direction perpendicular to the fin body.

23. The heat exchanger according to claim 1, wherein at least one of the plurality of heat exchange tubes is inserted into each of the plurality of the heat exchange tube grooves.

24. (canceled)