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(54) FIN-TUBE HEAT EXCHANGER AND REFRIGERATION CYCLE DEVICE USING SAME

RIPPENRÖHREN-WÄRMETAUSCHER UND KÄLTEKREISLAUFVORRICHTUNG DAMIT

ÉCHANGEUR DE CHALEUR À TUBE À AILETTES ET DISPOSITIF À CYCLE DE RÉFRIGÉRATION L'UTILISANT

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(73) Proprietor: **Panasonic Intellectual Property Management Co., Ltd.**
Osaka-shi, Osaka 540-6207 (JP)

(72) Inventors:
- **YAMAOKA, Yuuki**
  Osaka-shi, OSAKA 540-6207 (JP)
- **AOYAGI, Osamu**
  Osaka-shi, OSAKA 540-6207 (JP)
- **ANDOU, Tosiaki**
  Osaka-shi, OSAKA 540-6207 (JP)
- **KOISHIHARA, Kazuki**
  Osaka-shi, OSAKA 540-6207 (JP)

(74) Representative: **Eisenführ Speiser**
Patentanwälte Rechtsanwälte PartGmbB
Postfach 31 02 60
80102 München (DE)

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Description

[TECHNICAL FIELD]

[0001] The present invention especially relates to a fin-tube heat exchanger used for heat exchange of refrigerant.

[BACKGROUND TECHNIQUE]

[0002] As shown in Fig. 17, a conventional fin-tube heat exchanger of this kind is composed of a plurality of fins 1 arranged at predetermined intervals Fp from one another, and heat transfer pipes 2 inserted into the fins 1 substantially at right angles.

[0003] Fig. 18 (a) is a sectional view when fins configuring the conventional fin-tube heat exchanger are laminated on one another, and Fig. 18 (b) is a partial plan view of fins configuring the conventional fin-tube heat exchanger.

[0004] As shown in Figs. 18, a fin collar 3 rising from a surface of the fin 1 is formed on each of the fins 1, and the heat transfer pipe 2 is inserted into the fin collar 3. An end surface 30 of the fin collar 3 comes into contact with adjacent fins 1 and holds a predetermined distance between the fins 1.

[0005] Air current 100 (e.g., air) is introduced into the fin-tube heat exchanger by an air blower (not shown). The air current 100 flows through gaps between the laminated fins 1 and exchanges heat with fluid (e.g., refrigerant such as R410a and carbon dioxide) flowing through the heat transfer pipe 2.

[0006] Generally, fluid flowing through the heat transfer pipe 2 is in a two-phase state of a liquid phase and a gas phase. The liquid phase of the fluid evaporates by the heat exchange with the air current 100, and the liquid becomes overheated gas and flows out from the fin-tube heat exchanger.

[0007] In some cases, to facilitate the heat transfer for enhancing the efficiency in such a fin-tube heat exchanger, a cut-and-raised part 4 is formed over the entire region of each of the fin 1 as shown in Figs. 19 (see patent documents 1 and 2 for example).

[0008] Fig. 19 (a) is a sectional view when fins configuring the fin-tube heat exchanger described in patent document 1 are laminated on one another, and Fig. 19(b) is a partial plane view of the fin configuring the fin-tube heat exchanger described in patent document 1.

[0009] The cut-and-raised parts 4 shown in Figs. 19 have a louver shape formed by bending a portion of the fin 1 substantially perpendicularly to a fin flat surface 1c. The cut-and-raised parts 4 are inclined such that they are arranged on the fin 1 straightly from an upstream side to a downstream side of the air current 100, thereby reducing a dead water region which is generated in wake flow of the heat transfer pipe 2.

[0010] Fig. 20(a) is a sectional view when fins configuring a fin-tube heat exchanger described in patent document 2 are laminated on one another, and Fig. 20(b) is a partial plane view of the fin configuring the fin-tube heat exchanger described in patent document 2.

[0011] Cut-and-raised parts 4 shown in Figs. 20 are offset from each other such that flat surfaces of the cut-and-raised parts 4 are substantially in parallel to a fin flat surface 1c, and both ends of the cut-and-raised part 4 are connected to the fin flat surface 1c to form a slit. The cut-and-raised parts 4 are formed on the heat transfer pipe 2 on both upstream side and downstream side of the air current 100. A height of the cut-and-raised part 4 is set in a predetermined range. The fin-tube heat exchanger described in patent document 2 is provided with the cut-and-raised parts 4 shown in Figs. 20. According to this, extreme deterioration in transfer performance caused when frost is formed is suppressed.

[0012] Fig. 21(a) is a sectional view when fins configuring a fin-tube heat exchanger described in patent document 3 are laminated on one another, and Fig. 21(b) is a partial plane view of the fin configuring the fin-tube heat exchanger described in patent document 3.

[0013] Cut-and-raised parts 4 shown in Figs. 21 have a louver shape formed by bending a portion of the fin 1 substantially perpendicularly to a fin flat surface 1c. The cut-and-raised part 4 formed by bending the fin 1 form a cut-and-raised part openings 4c toward adjacent fins 1.

[0014] The cut-and-raised part 4 is placed on the fin 1 such that the cut-and-raised part 4 inclines with respect to a flowing direction of the air current 100, and the cut-and-raised part 4 intersects with the fin flat surface 1c as viewed from a direction perpendicular to the fin flat surface 1c. As a result, turbulence flow is promoted by collision between air currents 100 generated when the air current 100 passes through the cut-and-raised part openings 4c, and heat transfer of the fin-tube heat exchanger is promoted.

[0015] JP-A 2001091101 discloses a fin-tube heat exchanger according to the preamble of claim 1.

[PRIOR ART DOCUMENTS]

[PATENT DOCUMENTS]

[0016]

[Patent Document 1] Japanese Patent Application Laid-open No.2008-89237
[Patent Document 2] Japanese Patent Application Laid-open No.H11-125495
[Patent Document 3] Japanese Patent Application Laid-open No.2007-309533

[SUMMARY OF THE INVENTION]

[PROBLEM TO BE SOLVED BY THE INVENTION]

[0017] According to the conventional configurations, however, since the cut-and-raised parts 4 are formed

over the entire region of the fin 1. Therefore, much frost is formed on the fin 1 especially on the upstream side of the air current 100 of the fin 1 where heat is actively exchanged, and there is a problem that heat transfer performance is deteriorated.

[0018] Further, in the conventional configuration, water precipitated by the fin 1 stays at the cut-and-raised part 4 and does not smoothly flow down, and there is a problem that the heat transfer performance is deteriorated.

[0019] The present invention has been accomplished to solve the conventional problems, and it is an object of the invention to provide a fin-tube heat exchanger which reduces frost formed on a fin, which enhances drainage performance and which has excellent heat transfer performance.

[MEANS FOR SOLVING THE PROBLEM]

[0020] To solve the conventional problems, the present invention provides a fin-tube heat exchanger according to claim 1 including a plurality of fins which have cut-and-raised parts and through which air current passes, and a plurality of heat transfer pipes which penetrate the plurality of fins and through which fluid flows, wherein the cut-and-raised parts are placed only on a downstream side of a center of the closest heat transfer pipe with respect to the air current, and the cut-and-raised parts incline with respect to the air current.

[0021] According to this, the cut-and-raised part is provided only on the downstream side of the air current where frost is less prone to be formed, and it is possible to reduce the frost formation. Further, since water on the fin can be made to smoothly flow by the cut-and-raised part which inclines with respect to the air current direction, it is possible to enhance the drainage performance.

[EFFECT OF THE INVENTION]

[0022] According to the present invention, it is possible to provide a fin-tube heat exchanger in which an amount of formed frost is small, drainage performance is enhanced, and heat transfer performance is excellent.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0023]

Fig. 1(a) is a sectional view when fins of a fin-tube of the heat exchanger in a first embodiment of the present invention are laminated on one another, and Fig. 1(b) is a partial plane view of the fin of the fin-tube heat exchanger;
Fig. 2 is a partial plan view showing a positional relation between a cut-and-raised part and a heat transfer pipe in a fin of the fin-tube heat exchanger;
Fig. 3 is a sectional view showing a height Hs of the cut-and-raised part and a height Hw of a waveform in the fin of the fin-tube heat exchanger;
Fig. 4 is a sectional view showing the height Hs of the cut-and-raised part and a height Hc of a fin collar in the fin of the fin-tube heat exchanger;
Fig. 5 is an explanatory diagram of a drainage operation in the fin of the fin-tube heat exchanger;
Fig. 6 (a) is a sectional view when fins of different shape of a fin-tube heat exchanger in a second embodiment of the invention are laminated on one another, and Fig. 6(b) is a partial plane view of the fin of different shape of the fin-tube heat exchanger;
Fig. 7 (a) is a sectional view when fins of different shape of a fin-tube heat exchanger in a third embodiment of the invention are laminated on one another, and Fig. 7(b) is a partial plane view of the fin of different shape of the fin-tube heat exchanger;
Fig. 8 is a partial plan view of a fin of a fin-tube heat exchanger in a fourth embodiment of the invention
Fig. 9(a) is a sectional view when fins of a fin-tube heat exchanger in a fifth embodiment of the invention are laminated on one another, and Fig. 9 (b) is a partial plane view of the fin of the fin-tube heat exchanger;
Fig. 10 is a partial plane view of the fin showing a relation between a cut-and-raised part and isotherm of a fin in the fin of the fin-tube heat exchanger;
Fig. 11 is a sectional view showing a height Hs of the cut-and-raised part and a height Hw of a waveform in the fin of the fin-tube heat exchanger;
Fig. 12 is a sectional view showing a height Hs of the cut-and-raised part and a height Hc of the fin collar in the fin of the fin-tube heat exchanger;
Fig. 13 is an explanatory diagram of a drainage operation in the fin of the fin-tube heat exchanger;
Fig. 14(a) is a sectional view when fins of different shape of a fin-tube heat exchanger in a sixth embodiment of the invention are laminated on one another, and Fig. 14 (b) is a partial plane view of the fin of different shape of the fin-tube heat exchanger;
Fig. 15(a) is a sectional view when fins of different shape of a fin-tube heat exchanger in a seventh embodiment of the invention are laminated on one another, and Fig. 15 (b) is a partial plane view of the fin of different shape of the fin-tube heat exchanger;
Fig. 16 is a partial plane view of fins of a fin-tube heat exchanger in an eighth embodiment of the invention;
Fig. 17 is a diagram showing a configuration of a conventional fin-tube heat exchanger;
Fig. 18(a) is a sectional view when fins of the conventional fin-tube heat exchanger are laminated on one another, and Fig. 18(b) is a partial plane view of the fin of the fin-tube heat exchanger;
Fig. 19(a) is a sectional view when fins of different shape of another conventional fin-tube heat exchanger are laminated on one another, and Fig. 19(b) is a partial plane view of the fin of different shape of the fin-tube heat exchanger;
Fig. 20(a) is a sectional view when fins of different shape of another conventional fin-tube heat ex-

changer are laminated on one another, and Fig. 20(b) is a partial plane view of the fin of different shape of the fin-tube heat exchanger;

Fig. 21(a) is a sectional view when fins of different shape of another conventional fin-tube heat exchanger are laminated on one another, and Fig. 21(b) is a partial plane view of the fin of different shape of the fin-tube heat exchanger.

[EXPLANATION OF SYMBOLS]

[0024]

1	fin
1a	fin windward portion
1b	fin leeward portion
1c	fin flat surface
2	heat transfer pipe
3	fin collar
4	cut-and-raised part
4a	cut-and-raised side
4b	raised side
4c	cut-and-raised part opening
5	corrugated portion
6	seat
100	air current
N	radial direction phantom line
M	longitudinal direction phantom line

[MODE FOR CARRYING OUT THE INVENTION]

[0025] A first aspect of the invention provides a fin-tube heat exchanger including a plurality of fins which have cut-and-raised parts and through which air current passes, and a plurality of heat transfer pipes which penetrate the plurality of fins and through which fluid flows, wherein the cut-and-raised parts are placed only on a downstream side of a center of the closest heat transfer pipe with respect to the air current, and the cut-and-raised parts incline with respect to the air current.

[0026] According to this, the cut-and-raised part is provided only on the downstream side of the air current where frost is less prone to be formed, and it is possible to reduce the frost formation. Further, since water on the fin can be made to smoothly flow by the cut-and-raised part which inclines with respect to the air current direction, it is possible to enhance the drainage performance. Therefore, it is possible to enhance the heat transfer performance.

[0027] According to a second aspect of the invention, especially in the first aspect, each of the fins includes a flat seat formed around the heat transfer pipe, a fin flat surface formed from the seat to a fin end located on the downstream side with respect to the air current, and a corrugated portion which is formed around the seat and around the fin flat surface and which have alternately formed peaks and valleys, and the cut-and-raised part is placed on the fin flat surface.

[0028] According to this, since the corrugated portion is provided, a heat transfer area of the fin is increased. Further, water is induced by the fin flat surface formed from the seat around the heat transfer pipe to the fin end located on the downstream side of the air current, and it is possible to enhance the drainage performance.

[0029] According to a third aspect of the invention, especially in the first or second aspect, the cut-and-raised part is formed into a bridge shape by a pair of raised sides connected to the fin and by a pair of cut-and-raised sides which are separated from the fin, a slit is formed between the cut-and-raised side and the fin, and the raised side is formed in a vertical direction.

[0030] According to this, the raised side where water is prone to stay by surface tension is formed vertically, drainage water is made smoothly flow down and drainage performance is enhanced.

[0031] According to a fourth aspect of the invention, especially in the third aspect, one of the raised sides of the cut-and-raised part located on an upstream side with respect to the air current is in a position higher than an other raised side located on the downstream side with respect to the air current.

[0032] According to this, since precipitated water is guided toward the fin leeward end by its own weight and air current, drainage performance is enhanced.

[0033] According to a fifth aspect of the invention, especially in the third aspect, one of the raised sides of the cut-and-raised part located on an upstream side with respect to the air current is in a position lower than an other raised side located on the downstream side with respect to the air current.

[0034] According to this, since precipitated water is guided to a valley of the corrugated portion and is made to smoothly flow down, drainage performance is enhanced.

[0035] According to a sixth aspect of the invention, especially in the first aspect, the cut-and-raised part is formed in a direction perpendicular to a straight line passing through the center of the closest heat transfer pipe.

[0036] This configuration hinders heat transfer from a fin between the cut-and-raised part and the heat transfer pipe toward a fin downstream of the cut-and-raised part. Therefore, under an operating condition where frost is formed on the fin, it is possible to suppress frost formation on the fin located downstream of the cut-and-raised part in the air current direction.

[0037] According to a seventh aspect of the invention, especially in the first aspect, the cut-and-raised part is formed parallel to a straight line passing through the center of the heat transfer pipe.

[0038] According to this, since the cut-and-raised part is placed in parallel to a center axis of the heat transfer pipe, it is possible to maintain heat exchange performance without deteriorating heat transfer toward the leeward of the cut-and-raised part.

[0039] According to an eighth aspect of the invention, especially in the second aspect, the fin includes a fin

collar into which the heat transfer pipe is inserted, and the cut-and-raised part, the corrugated portion and the fin collar become larger in size in this order.

[0040] According to this, it is possible to make it easy to laminate the fins.

[0041] According to a ninth aspect of the invention, especially in any one of the first to eighth aspects, at least one of the fins located on an upstream side and one of the fins located on a downstream side are placed in a direction of the air current, and a height of the heat transfer pipe of the fin on the upstream side and a height of the heat transfer pipe of the fin on the downstream side are different from each other.

[0042] According to this, since air current passing through the fin-tube heat exchanger can be guided to the entire fins, the fin-tube heat exchanger can substantially uniformly promote the heat transfer by the cut-and-raised part, and it is possible to uniform heat flux, to further promote the heat transfer, and to enhance the heat exchange ability.

[0043] Embodiments of the present invention will be described below with reference to the drawings. The invention is not limited to the embodiments.

(First Embodiment)

[0044] Like the conventional fin-tube heat exchanger shown in Figs. 18, a fin-tube heat exchanger in a first embodiment of the present invention is composed of a plurality of fins 1 arranged at predetermined intervals Fp from one another and heat transfer pipes 2 inserted into the fins 1 substantially at right angles. Here, the invention will be described based on a case where the fin-tube heat exchanger is used as an evaporator.

[0045] Fig. 1(a) is a sectional view the fin configuring the fin-tube of the heat exchanger in the first embodiment, and Fig. 1(b) is a partial plane view of the fin of the fin-tube heat exchanger.

[0046] As shown in Fig. 1, the fin 1 includes a flat seat 6, a fin flat surface 1c and a corrugated portion 5. Generally, the corrugated portion 5 is also called corrugate or waffle.

[0047] The seat 6 is formed around a heat transfer pipe 2, and guides air current 100 to peripheries of a fin collar 3. The fin flat surface 1c is formed from the seat 6 to a fin end 1d located downstream of the air current 100. The corrugated portion 5 is formed around the seat 6 and the fin flat surface 1c, and peaks and valleys are alternately formed.

[0048] A cut-and-raised part 4 is placed on the fin flat surface 1c. The cut-and-raised part 4 is formed by offsetting a portion of the fin 1 from the fin flat surface 1c in a slit form.

[0049] The cut-and-raised part 4 is formed into a bridge shape by a pair of raised sides 4b connected to the fin flat surface 1c and by a pair of cut-and-raised sides 4a separated from the fin flat surface 1c. A cut-and-raised part opening (slit) 4c is formed between the cut-and-raised sides 4a and the fin flat surface 1c.

[0050] The raised sides 4b are formed in the vertical direction.

[0051] The cut-and-raised part 4 is placed only downstream of a center of the closest heat transfer pipe 2 in the direction of the air current 100, and the cut-and-raised part 4 inclines with respect to the air current 100. The raised side 4b located upstream of the air current 100 is located at a position higher than the raised side 4b located downstream of the air current 100. Of boundary lines between the fin flat surface 1c and the corrugated portion 5, a boundary line between the upper side and the lower side inclines in the same direction as the cut-and-raised part 4.

[0052] The cut-and-raised part openings 4c are formed in an upper portion and a lower portion of the cut-and-raised part 4. Condensed drainage water flows down into the cut-and-raised part opening 4c and air current 100 passes through the cut-and-raised part opening 4c. Since the raised side 4b is formed in the vertical direction, condensed drainage water easily flows down along the raised side 4b by the gravity.

[0053] Centering on a phantom line L which connects centers of the heat transfer pipes 2 to each other, if an upstream side of the air current 100 is defined as a fin windward portion 1a and a downstream side of the air current 100 is defined as a fin leeward portion 1b, the cut-and-raised part 4 is placed only on the fin leeward portion 1b. The corrugated portions 5 are placed on the fin windward portion 1a and the fin leeward portion 1b. The cut-and-raised part 4 is placed on the fin flat surface 1c located on an outer side of the seat 6.

[0054] As shown in Fig. 2, the cut-and-raised part 4 is formed in a direction (longitudinal direction) perpendicular to a radial direction phantom line N passing through a center of the closest heat transfer pipe 2. That is, the cut-and-raised part 4 is placed such that the straight cut-and-raised side 4a intersects, at right angles, with the radial direction phantom line N of the heat transfer pipe 2 which is closest to the cut-and-raised part 4.

[0055] As shown in Figs. 3 and 4, a height of the fin collar 3 is defined as Hc (e.g., 1.5 mm), a height of the cut-and-raised part 4 is defined as Hs (e.g., 0.75 mm) and a height of the corrugated portion 5 is defined as Hw (e.g., 1mm). Here, these members are formed such that a relation Hc>Hw>Hs is satisfied. All of the cut-and-raised parts 4 rise in the same direction with respect to the fin flat surface 1c.

[0056] An operation of the fin-tube heat exchanger having the above-described configuration will be described below.

[0057] In the fin-tube heat exchanger of this embodiment, at the fin windward portion 1a formed on the corrugated portion 5, since air current 100 passing through a gap of the fin 1 snakes, turbulence flow is promoted. At the fin leeward portion 1b, the air current 100 passes through the cut-and-raised part 4, and a temperature boundary layer is formed on the cut-and-raised side 4a.

[0058] Generally, the cut-and-raised part 4 promotes heat transfer. Therefore, if the corrugated portion 5 and the cut-and-raised part 4 are placed, heat transfer of the fin leeward portion 1b having low thermal flow rate is promoted, and thermal flow rates of the fin windward portion 1a and the fin leeward portion 1b become relatively uniform.

[0059] Especially, under an operating condition that temperature of the fin 1 becomes lower than 0°C and frost is formed on the fin-tube heat exchanger, frost formation on the fin leeward portion 1b is promoted by the cut-and-raised part 4, and frost formation on the fin windward portion 1a and frost formation on the fin leeward portion 1b become relatively uniform.

[0060] The cut-and-raised part 4 is placed such that the cut-and-raised side 4a (longitudinal direction phantom line M of cut-and-raised part 4) and the longitudinal direction phantom line N of the heat transfer pipe 2 which comes closest to this cut-and-raised part 4 intersect with each other at right angles. According to this, of the fin leeward portion 1b, heat transferred from the fin 1 between the heat transfer pipe 2 and the cut-and-raised part 4 to a region A of the fin 1 located downstream of the cut-and-raised part 4 in the direction of the air current 100 is shut off. Hence, under an operating condition that the temperature of the fin 1 becomes less than 0°C and frost is formed on the fin-tube heat exchanger, it is possible to restrain frost from being formed in the region A and even if the cut-and-raised part 4 is closed by the frost, the region A can be secured as an air trunk of the air current 100.

[0061] As shown in Fig. 3, the height Hw of the corrugated portion 5 is set higher than the height Hs of the cut-and-raised part 4. According to this, air current 100 guided by the corrugated portion 5 reliably passes through the cut-and-raised part 4 and heat transfer in the cut-and-raised part 4 can be promoted.

[0062] Since the cut-and-raised part 4 is formed from the fin flat surface 1c in the same direction as the fin collar 3, eddy of the air current 100 is not generated in the vicinity of the cut-and-raised part 4, and the air current 100 does not snake more than necessary. Hence, it is possible to restrain ventilation resistance caused by the cut-and-raised part 4 from increasing.

[0063] The cut-and-raised part 4 opens upward and downward by the cut-and-raised opening 4c and inclines such that upstream side of the cut-and-raised part 4 in the direction of the air current 100 becomes high. Hence, as shown in Fig. 5, drainage water which adheres to the cut-and-raised part 4 flows down by the air current 100 in addition to its own weight. Of drainage water which adheres to the cut-and-raised part 4, drainage water which flows down to the fin flat surface 1c flows down by the air current 100 in addition to its own weight along the boundary line which inclines in the same direction as that of the cut-and-raised part 4.

[0064] Therefore, the drainage water smoothly flows down against surface tension of the fin 1 which tries to stay the drainage water, and to reduce an amount of water staying on the fin 1. According to this, even under an operating condition that drainage water adheres to the fin 1, it is possible to enhance the drainage performance of drainage water and to reduce the ventilation resistance of the fin-tube heat exchanger.

[0065] Under an operating condition that the temperature of the fin 1 becomes less than 0°C and frost is formed on the fin-tube heat exchanger, at the time of defrosting, melted water produced when frost is melted smoothly flows down utilizing the inclination of the cut-and-raised part 4. Therefore, at the time of returning, it is possible to avoid a case where melted water staying on the fin 1 is again frozen and ventilation resistance is increased.

[0066] Further, by setting the height Hc of the fin collar 3 higher than the height Hs of the cut-and-raised part 4 as shown in Fig. 4, the adjacent fin flat surface 1c and cut-and-raised part 4 do not come into contact with each other, and the amount of drainage water staying due to the surface tension of the fin 1 can be reduced.

[0067] According to this, even under an operating condition that drainage water adheres to the fin 1, it is possible to enhance the drainage performance of drainage water, and to reduce the ventilation resistance of the fin-tube heat exchanger.

[0068] Further, since the cut-and-raised part 4 is placed on an outer side of the seat 6, it is possible to secure a predetermined interval between the cut-and-raised part 4 and the fin collar 3. Hence, drainage water which adheres to the cut-and-raised part 4 does not stay between the cut-and-raised part 4 and the fin collar 3 by the surface tension, and flows downward. Therefore, even under the operating condition that drainage water adheres to the fin 1, it is possible to enhance the drainage performance of drainage water and to reduce the ventilation resistance of the fin-tube heat exchanger.

[0069] When the seat 6 and the fin flat surface 1c are formed on the same plane, a length formed between contact points 20 of the corrugated portion 5 and the seat 6 is defined as a distance D, a circular region having the distance D as a diameter is defined as the seat 6, and outside of the seat 6 is defined as the fin flat surface 1c.

[0070] As described above, in this embodiment, the cut-and-raised part 4 which inclines with respect to the air current 100 is provided on the fin leeward portion 1b, and heat transfer of the fin leeward portion 1b is promoted. Hence, under the operating condition that the temperature of the fin 1 becomes less than 0°C, frost is formed on the fin windward portion 1a and the fin leeward portion 1b relatively uniformly and in addition, melted water produced at the time of defrosting is less prone to stay on the fin 1.

[0071] Hence, it is possible to avoid a case where frost is locally formed on the cut-and-raised part 4 and ventilation resistance abruptly increases, reduction in a heat exchanging amount is suppressed, and heat transfer is promoted by the cut-and-raised part 4. Further, it is pos-

sible to largely improve frost formation on the conventional fin-tube heat exchanger.

[0072] Although the cut-and-raised part 4 and the fin collar 3 are provided in the same direction in this embodiment, the cut-and-raised part 4 may be formed in a direction different from the fin collar 3.

(Second Embodiment)

[0073] Figs. 6 show a second embodiment of the invention. The same symbols are allocated to configurations having the same functions as those of the first embodiment, description thereof will be omitted, and only configurations which are different from the first embodiment will be described below.

[0074] Some of cut-and-raised parts 4 are formed by offsetting a portion of a fin 1 shown in Fig. 1 in a slit form. In addition, the cut-and-raised parts 4 may be formed by bending a portion of a fin 1 shown in Figs. 6(a) and 6(b) substantially perpendicularly to a fin flat surface 1c.

[0075] In the second embodiment, one side is a raised side 4b, and other three sides are cut-and-raised sides 4a which are separated from a fin flat surface 1c. By bending the portion of the fin 1 by the raised side 4b, a cut-and-raised opening 4c is formed.

(Third Embodiment)

[0076] Figs. 7 show a third embodiment of the invention. The same symbols are allocated to configurations having the same functions as those of the first embodiment, description thereof will be omitted, and only configurations which are different from the first embodiment will be described below.

[0077] As shown in Figs. 7(a) and 7(b), a cut-and-raised part 4 inclines such that a downstream side thereof in the direction of air current 100 is located at a high position.

[0078] That is, in the cut-and-raised part 4, the raised side 4b located on the upstream side of the air current 100 is located at a position lower than a raised side 4b located on the downstream side of air current 100. Of the boundary lines between a fin flat surface 1c and a corrugated portion 5, a boundary line between the upper side and the lower side inclines in the same direction as the cut-and-raised part 4.

[0079] According to this configuration, at the time of defrosting, melted water produced when frost is melted smoothly flows down utilizing the inclination of the cut-and-raised part 4. Of drainage water which adheres to the cut-and-raised part 4, drainage water which flows down to the fin flat surface 1c flows down along the boundary line which inclines in the same direction as the cut-and-raised part 4. By peaks and valleys formed by the corrugated portions 5, melted water flows downward in the gravity direction. Hence, it is possible to reduce the amount of water staying at a fin 1, and to avoid a case where melted water after defrosting and returning is again frozen to increase the ventilation resistance.

[0080] By forming the corrugated portions 5 on the upstream side and the downstream side of the air current 100, a temperature boundary layer in the surface of the fin 1 is disturbed and heat transfer is promoted. Therefore, the frost formation is reduced, drainage performance is maintained, and heat exchanging ability can be enhanced.

[0081] Although it is described in the embodiment that the heat transfer pipe 2 is a round pipe, the heat transfer pipe 2 may be a flat pipe for example.

[0082] Further, the cut-and-raised part 4 described in the second embodiment may be applied to the third embodiment.

(Fourth Embodiment)

[0083] Fig. 8 is a partial plane view of a fin configuring a fin-tube heat exchanger in a fourth embodiment of the invention. The same symbols are allocated to the same members as those of the first to third embodiments, and detailed description thereof will be omitted,

[0084] As shown in Fig. 8, in the fin-tube heat exchanger in the fourth embodiment, a plurality of fins 1 are arranged in parallel to a direction of air current 100. That is, in the fin-tube heat exchanger in the fourth embodiment, at least a fin 1 in a first row located on the upstream side and the fin 1 in a second row located on the downstream side are placed.

[0085] A height of a heat transfer pipe 2 of the fin 1 in the first row on the upstream side and a height of the heat transfer pipe 2 of the fin 1 in the second row on the downstream side are different from each other. It is preferable that the heat transfer pipe 2 of the fin 1 in the second row is placed between the two heat transfer pipes 2 of the fin 1 in the first row.

[0086] According to the fin-tube heat exchanger of the fourth embodiment, the air current 100 which passes through the fin 1 in the first row easily exchanges heat with the heat transfer pipe 2 of the fin 1 in the second row.

[0087] The air current 100 passes through any one of cut-and-raised parts 4 provided in the fin 1 in the first row and the fin 1 in the second row. Therefore, a temperature boundary layer is formed in the air current 100 by the cut-and-raised part 4 in the first row and the second row relatively uniformly, and heat transfer can be promoted.

[0088] As described above, in the fourth embodiment, the fin leeward portion 1b is provided with the cut-and-raised part 4 which inclines with respect to the air current 100, the fins 1 are arranged in two rows in the direction of the air current 100, and the height of the heat transfer pipe 2 of the fin 1 in the first row and the height of the heat transfer pipe 2 of the fin 1 in the second row on the downstream side are different from each other.

[0089] According to this, heat transfer of the air current 100 passing through any of the positions of the fin-tube heat exchanger is promoted by the cut-and-raised part 4 relatively uniformly, and heat exchange ability can be

enhanced.

[0090] Under the operating condition that the surface temperature of the fin 1 becomes less than 0°C, frost is formed on the fin windward portion 1a and the fin leeward portion 1b relatively uniformly, and at the time of defrosting, it is possible to prevent melted water from being again frozen, and it is possible to remarkably improve the frost formation on the fin-tube heat exchanger having the conventional cut-and-raised parts 4.

(Fifth Embodiment)

[0091] A fifth embodiment of the invention will be described with reference to the drawing.

[0092] Like the conventional fin-tube heat exchanger shown in Figs. 18, a fin-tube heat exchanger in the fifth embodiment of the invention is composed of a plurality of fins 1 arranged at predetermined intervals Fp from one another, and heat transfer pipes 2 inserted into the fins 1 substantially at right angles. The fifth embodiment will be described based on an example in which the fin-tube heat exchanger is used as an evaporator.

[0093] Fig. 9 (a) is a sectional view of the fin configuring the fin-tube heat exchanger in the fifth embodiment, and Fig. 9(b) is a partial plane view of the fin of the fin-tube heat exchanger.

[0094] As shown in Fig. 9, the fin 1 includes flat seats 6, fin flat surfaces 1c and corrugated portions 5. Generally, the corrugated portion 5 is also called corrugate or waffle.

[0095] The seat 6 is formed around the heat transfer pipe 2, and guides air current 100 to peripheries of a fin collar 3. The fin flat surface 1c is formed from the seat 6 to a fin end 1d located downstream of the air current 100. The corrugated portion 5 is formed around the seat 6 and the fin flat surface 1c, and peaks and valleys are alternately formed.

[0096] A cut-and-raised part 4 is placed on the fin flat surface 1c. The cut-and-raised part 4 is formed by offsetting a portion of the fin flat surface 1c from the fin flat surface 1c in a slit form.

[0097] The cut-and-raised part 4 is formed into a bridge shape by a pair of raised sides 4b connected to the fin flat surface 1c and by a pair of cut-and-raised sides 4a separated from the fin flat surface 1c. A cut-and-raised part opening (slit) 4c is formed between the cut-and-raised sides 4a and the fin flat surface 1c.

[0098] The raised sides 4b are formed in the vertical direction.

[0099] The cut-and-raised part 4 is placed only downstream of a center of the closest heat transfer pipe 2 in the direction of the air current 100, and the cut-and-raised part 4 inclines with respect to the air current 100. The raised side 4b located upstream of the air current 100 is located at a position higher than the raised side 4b located downstream of the air current 100. Of boundary lines between the fin flat surface 1c and the corrugated portion 5, a boundary line between the upper side and the lower side inclines in the same direction as the cut-and-raised part 4.

[0100] The cut-and-raised part 4 is parallel to a radial direction phantom line N passing through a center of the heat transfer pipe 2.

[0101] The two cut-and-raised parts 4 of the fifth embodiment are placed on both sides of the radial direction phantom line N passing through the center of the heat transfer pipe 2 such that the upstream side of the air current 100 comes on the upper side.

[0102] The cut-and-raised part openings 4c are formed in an upper portion and a lower portion of the cut-and-raised part 4. Condensed drainage water flows down into the cut-and-raised part opening 4c and air current 100 passes through the cut-and-raised part opening 4c. Since the raised side 4b is formed in the vertical direction, condensed drainage water easily flows down along the raised side 4b by the gravity.

[0103] Centering on a phantom line L which connects centers of the heat transfer pipes 2 to each other, if an upstream side of the air current 100 is defined as a fin windward portion 1a and a downstream side of the air current 100 is defined as a fin leeward portion 1b, the cut-and-raised part 4 is placed only on the fin leeward portion 1b. The corrugated portions 5 are placed on the fin windward portion 1a and the fin leeward portion 1b. The cut-and-raised part 4 is placed on the fin flat surface 1c located on an outer side of the seat 6 which is formed into a circular shape around the fin collar 3.

[0104] As shown in Figs. 11 and 12, a height of the fin collar 3 is defined as Hc (e.g., 1.5 mm), a height of the cut-and-raised part 4 is defined as Hs (e.g., 0.75 mm) and a height of the corrugated portion 5 is defined as Hw (e.g., 1 mm). Here, these members are formed such that a relation Hc>Hw>Hs is satisfied. All of the cut-and-raised parts 4 rise in the same direction with respect to the fin flat surface 1c.

[0105] An operation of the fin-tube heat exchanger having the above-described configuration will be described below.

[0106] In the fin-tube heat exchanger of this embodiment, at the fin windward portion 1a formed on the corrugated portion 5, since air current 100 passing through a gap of the fin 1 snakes, turbulence flow is promoted. At the fin leeward portion 1b, the air current 100 passes through the cut-and-raised part 4, and a temperature boundary layer is formed on the cut-and-raised side 4a.

[0107] Generally, the cut-and-raised part 4 promotes heat transfer. Therefore, if the corrugated portion 5 and the cut-and-raised part 4 are placed, heat transfer of the fin leeward portion 1b having low thermal flow rate is promoted, and thermal flow rates of the fin windward portion 1a and the fin leeward portion 1b become relatively uniform.

[0108] Especially, under an operating condition that temperature of the fin 1 becomes lower than 0°C and frost is formed on the fin-tube heat exchanger, frost formation on the fin leeward portion 1b is promoted by the

cut-and-raised part 4, and frost formation on the fin windward portion 1a and frost formation on the fin leeward portion 1b become relatively uniform.

[0109] The cut-and-raised part 4 is placed substantially parallel to the radial direction phantom line N of the heat transfer pipe 2. Normally, heat is transferred between the heat transfer pipe 2 and the fin 1 such that isotherms T0, T1, T2, T3, T4 ... radially spread from a center of the heat transfer pipe 2 as shown in Fig. 10. Hence, the cut-and-raised part 4 and the isotherms which spread from the heat transfer pipe 2 intersect with each other substantially perpendicularly.

[0110] That is, heat moves in a direction perpendicular to the isotherm as shown by broken arrows in Fig. 10. Hence, although the cut-and-raised part 4 placed substantially parallel to the radial direction phantom line N forms a discontinuous surface on the fin 1, heat transfer between the fin 1 and the heat transfer pipe 2 is not blocked, and the cut-and-raised part 4 does not act as heat resistance between the fin 1 and the heat transfer pipe 2.

[0111] The cut-and-raised part 4 which is placed substantially parallel to the radial direction phantom line N of the heat transfer pipe 2 promotes heat transfer between the heat transfer pipe 2 and an end of the fin 1 having a great distance from the heat transfer pipe 2. According to this, a thermal flow rate in the vicinity of the heat transfer pipe 2 and a thermal flow rate around the end of the fin 1 become relatively uniform.

[0112] As shown in Fig. 11, the height Hw of the corrugated portion 5 is made higher than the height Hs of the cut-and-raised part 4. According to this, the air current 100 which is guided by the corrugated portion 5 more reliably passes through the cut-and-raised part 4, and it is possible to promote the heat transfer by the cut-and-raised part 4.

[0113] Since the cut-and-raised part 4 is formed from the fin flat surface 1c in the same direction as the fin collar 3, eddy of the air current 100 is not generated in the vicinity of the cut-and-raised part 4, and the air current 100 does not snake more than necessary. Hence, it is possible to restrain ventilation resistance caused by the cut-and-raised part 4 from increasing.

[0114] The cut-and-raised part 4 opens upward and downward by the cut-and-raised opening 4c and inclines such that upstream side of the cut-and-raised part 4 in the direction of the air current 100 becomes high. Hence, as shown in Fig. 13, drainage water which adheres to the cut-and-raised part 4 flows down by the air current 100 in addition to its own weight. Of drainage water which adheres to the cut-and-raised part 4, drainage water which flows down to the fin flat surface 1c flows down by the air current 100 in addition to its own weight along the boundary line which inclines in the same direction as that of the cut-and-raised part 4.

[0115] Therefore, the drainage water smoothly flows down against surface tension of the fin 1 which tries to stay the drainage water, and to reduce an amount of water staying on the fin 1. According to this, even under an operating condition that drainage water adheres to the fin 1, it is possible to enhance the drainage performance of drainage water and to reduce the ventilation resistance of the fin-tube heat exchanger.

[0116] Under an operating condition that the temperature of the fin 1 becomes less than 0°C and frost is formed on the fin-tube heat exchanger, at the time of defrosting, melted water produced when frost is melted smoothly flows down utilizing the inclination of the cut-and-raised part 4. Therefore, at the time of defrosting and returning, it is possible to avoid a case where melted water staying on the fin 1 is again frozen and ventilation resistance is increased.

[0117] Further, by setting the height Hc of the fin collar 3 higher than the height Hs of the cut-and-raised part 4 as shown in Fig. 12, the adjacent fin flat surface 1c and cut-and-raised part 4 do not come into contact with each other, and the amount of drainage water staying between the laminated fins 1 due to the surface tension of the fin 1 can be reduced.

[0118] According to this, even under an operating condition that drainage water adheres to the fin 1, it is possible to enhance the drainage performance of drainage water, and to reduce the ventilation resistance of the fin-tube heat exchanger.

[0119] Further, since the cut-and-raised part 4 is placed on an outer side of the circular seat 6 which is formed around the fin collar 3, it is possible to secure a predetermined interval between the cut-and-raised part 4 and the fin collar 3. Hence, drainage water which adheres to the cut-and-raised part 4 does not stay between the cut-and-raised part 4 and the fin collar 3 by the surface tension, and flows downward. Therefore, even under the operating condition that drainage water adheres to the fin 1, it is possible to enhance the drainage performance of drainage water and to reduce the ventilation resistance of the fin-tube heat exchanger.

[0120] When the seat 6 and the fin flat surface 1c are formed on the same plane, a length formed between contact points 20 of the corrugated portion 5 and the seat 6 is defined as a distance D, a circular region having the distance D as a diameter is defined as the seat 6, and outside of the seat 6 is defined as the fin flat surface 1c.

[0121] As described above, in this embodiment, the cut-and-raised part 4 which inclines with respect to the air current 100 is provided on the fin leeward portion 1b, and heat transfer of the fin leeward portion 1b is promoted. Hence, under the operating condition that the temperature of the fin 1 becomes less than 0°C, frost is formed on the fin windward portion 1a and the fin leeward portion 1b relatively uniformly and in addition, melted water produced at the time of defrosting is less prone to stay on the fin 1.

[0122] Hence, it is possible to avoid a case where frost is locally formed on the cut-and-raised part 4 and ventilation resistance abruptly increases, reduction in a heat exchanging amount is suppressed, and heat transfer is

promoted by the cut-and-raised part 4. Further, it is possible to largely improve frost formation on the conventional fin-tube heat exchanger.

[0123] Although the cut-and-raised part 4 and the fin collar 3 are provided in the same direction in this embodiment, the cut-and-raised part 4 may be formed in a direction different from the fin collar 3.

(Sixth Embodiment)

[0124] Figs. 14 show a sixth embodiment of the invention. The same symbols are allocated to configurations having the same functions as those of the fifth embodiment, description thereof will be omitted, and only configurations which are different from the fifth embodiment will be described below.

[0125] Some of cut-and-raised parts 4 are formed by offsetting a portion of a fin 1 shown in Fig. 9 in a slit form. In addition, the cut-and-raised parts 4 may be formed by bending a portion of a fin 1 shown in Figs. 14(a) and 14(b) substantially perpendicularly to a fin flat surface 1c.

[0126] In the sixth embodiment, one side is a raised side 4b, and other three sides are cut-and-raised sides 4a which are separated from a fin flat surface 1c. By bending the portion of the fin 1 by the raised side 4b, a cut-and-raised opening 4c is formed.

(Seventh Embodiment)

[0127] Figs. 15 show a seventh embodiment of the invention. The same symbols are allocated to configurations having the same functions as those of the fifth embodiment, description thereof will be omitted, and only configurations which are different from the fifth embodiment will be described below.

[0128] As shown in Figs. 15 (a) and 15 (b), a cut-and-raised part 4 inclines such that a downstream side thereof in the direction of air current 100 is located at a high position.

[0129] That is, in the cut-and-raised part 4, the raised side 4b located on the upstream side of the air current 100 is located at a position lower than a raised side 4b located on the downstream side of air current 100. Of the boundary lines between a fin flat surface 1c and a corrugated portion 5, a boundary line between the upper side and the lower side inclines in the same direction as the cut-and-raised part 4.

[0130] According to this configuration, at the time of defrosting, melted water produced when frost is melted smoothly flows down utilizing the inclination of the cut-and-raised part 4. Of drainage water which adheres to the cut-and-raised part 4, drainage water which flows down to the fin flat surface 1c flows down along the boundary line which inclines in the same direction as the cut-and-raised part 4. By peaks and valleys formed by the corrugated portions 5, melted water flows downward in the gravity direction. Hence, it is possible to reduce the amount of water staying at a fin 1, and to avoid a case where melted water after defrosting and returning is again frozen to increase the ventilation resistance.

[0131] By forming the corrugated portions 5 on the upstream side and the downstream side of the air current 100, a temperature boundary layer in the surface of the fin 1 is disturbed and heat transfer is promoted. Therefore, the frost formation is reduced, drainage performance is maintained, and heat exchanging ability can be enhanced.

[0132] Although it is described in the embodiment that the heat transfer pipe 2 is a round pipe, the heat transfer pipe 2 may be a flat pipe for example.

[0133] Further, the cut-and-raised part 4 described in the sixth embodiment may be applied to the seventh embodiment.

(Eighth Embodiment)

[0134] Fig. 16 is a partial plane view of a fin configuring a fin-tube heat exchanger in an eighth embodiment of the invention. The same symbols are allocated to the same members as those of the first to seventh embodiments, and detailed description thereof will be omitted,

[0135] As shown in Fig. 16, in the fin-tube heat exchanger in the eighth embodiment, a plurality of fins 1 are arranged in parallel to a direction of air current 100. That is, in the fin-tube heat exchanger in the eighth embodiment, at least a fin 1 in a first row located on the upstream side and the fin 1 in a second row located on the downstream side are placed.

[0136] A height of a heat transfer pipe 2 of the fin 1 in the first row on the upstream side and a height of the heat transfer pipe 2 of the fin 1 in the second row on the downstream side are different from each other. It is preferable that the heat transfer pipe 2 of the fin 1 in the second row is placed between the two heat transfer pipes 2 of the fin 1 in the first row.

[0137] According to the fin-tube heat exchanger of this embodiment, the air current 100 which passes through the fin 1 in the first row easily exchanges heat with the heat transfer pipe 2 of the fin 1 in the second row.

[0138] The air current 100 passes through any one of cut-and-raised parts 4 provided in the fin 1 in the first row and the fin 1 in the second row. Therefore, a temperature boundary layer is formed by the cut-and-raised part 4, and heat transfer can be promoted.

[0139] As described above, in the this embodiment, the fin leeward portion 1b is provided with the cut-and-raised part 4 which inclines with respect to the air current 100, the fins 1 are arranged in two rows in the direction of the air current 100, and the height of the heat transfer pipe 2 of the fin 1 in the first row and the height of the heat transfer pipe 2 of the fin 1 in the second row on the downstream side are different from each other.

[0140] According to this, heat transfer of the air current 100 passing through any of the positions of the fin-tube heat exchanger is promoted by the cut-and-raised part 4, and heat exchange ability can be enhanced.

[0141] Under the operating condition that the surface temperature of the fin 1 becomes less than 0°C, frost is formed on the fin windward portion 1a and the fin leeward portion 1b relatively uniformly, and at the time of defrosting, it is possible to prevent melted water from being again frozen, and it is possible to remarkably improve the frost formation on the fin-tube heat exchanger having the conventional cut-and-raised parts 4.

[INDUSTRIAL APPLICABILITY]

[0142] As described above, the fin-tube heat exchanger of the present invention is formed only on the downstream side of the fin with respect to the direction of air current, frost formation can be reduced by the cut-and-raised part which inclines with respect to the direction of the air current, and drainage performance can be enhanced. Therefore, the invention can be applied to a heat exchanger of a refrigeration cycle device used for an air conditioner, a water heater and a heating system.

Claims

1. A fin-tube heat exchanger comprising
a plurality of fins (1) which have cut-and-raised parts (4) and through which air current passes, and
a plurality of heat transfer pipes (2) which penetrate the plurality of fins (1) and through which fluid flows, wherein
each of the fins (1) includes a flat seat (6) formed around the heat transfer pipe (2); a fin flat surface (1c) formed from the seat (6) to a fin end (1d) located on downstream side with respect to the air current, and a corrugated portion (5) which has alternately formed peaks and valleys,
the cut-and-raised parts (4) are placed only on the fin flat surface (1c) of the downstream side of a center of the closest heat transfer pipe with respect to the air current,
characterised in that said corrugated portion (5) is formed around the seat and around the fin flat surface, said cut-and-raised parts (4) incline with respect to the air current, and
the fin-tube heat exchange comprises of boundary lines between the fin flat surface (1c) on which the cut-and raised part (4) is placed and the corrugated portion (5), wherein a boundary line of a lower side of the cut-and raised part inclines in the same direction as the cut-and raised part.

2. The fin-tube heat exchanger according to claim 1, wherein the cut-and-raised part is formed into a bridge shape by a pair of raised sides connected to the fin and by a pair of cut-and-raised sides which are separated from the fin,
a slit is formed between the cut-and-raised side and the fin, and
the raised side is formed in a vertical direction.

3. The fin-tube heat exchanger according to claim 2, wherein one of the raised sides of the cut-and-raised part located on an upstream side with respect to the air current is in a position higher than an other raised side located on the downstream side with respect to the air current.

4. The fin-tube heat exchanger according to claim 2, wherein one of the raised sides of the cut-and-raised part located on an upstream side with respect to the air current is in a position lower than an other raised side located on the downstream side with respect to the air current.

5. The fin-tube heat exchanger according to claim 1, wherein the cut-and-raised part is formed in a direction perpendicular to a straight line passing through the center of the closest heat transfer pipe.

6. The fin-tube heat exchanger according to claim 1, wherein the cut-and-raised part is formed parallel to a straight line passing through the center of the heat transfer pipe.

7. The fin-tube heat exchanger according to claim 1, wherein the fin includes a fin collar into which the heat transfer pipe is inserted, and
the cut-and-raised part, the corrugated portion and the fin collar become larger in size in this order.

8. The fin-tube heat exchanger according to any one of claims 1 to 7, wherein at least one of the fins located on an upstream side and one of the fins located on a downstream side are placed in a direction of the air current, and
a height of the heat transfer pipe of the fin on the upstream side and a height of the heat transfer pipe of the fin on the downstream side are different from each other.

9. A refrigeration cycle device comprising the fin-tube heat exchanger according to any one of claims 1 to 8.

Patentansprüche

1. Rippenrohr-Wärmetauscher umfassend
eine Mehrzahl von Rippen (1), die eingeschnittene und herausstehende Teile (4) haben, und durch die ein Luftstrom fließt, und
eine Mehrzahl von Wärmeübertragungsrohren (2), welche die Mehrzahl von Rippen (1) durchziehen und durch die ein Fluid fließt, wobei
jede der Rippen (1) eine flache Aufnahme (6), die um das Wärmeübertragungsrohr (2) gebildet ist, eine flache Rippenoberfläche (1c), die von der Auf-

nahme (6) zu einem Rippenende (1d), das auf einer stromabwärtigen Seite im Hinblick auf den Luftstrom angeordnet ist, gebildet ist, und einen gewellten Abschnitt (5), der abwechselnd geformte Spitzen und Täler hat, umfasst,
die eingeschnittenen und herausstehenden Teile (4) nur an der flachen Rippenoberfläche (1c) der stromabwärtigen Seite eines Zentrums des naheliegensten Wärmeübertragungsrohres im Hinblick auf den Luftstrom positioniert sind,
dadurch gekennzeichnet, dass der gewellte Abschnitt (5) um die Aufnahme (6) und die flache Rippenoberfläche gebildet ist, die eingeschnittenen und herausstehenden Teile (4) sich im Hinblick auf den Luftstrom neigen, und
der Rippenrohr-Wärmetauscher Grenzlinien zwischen der flachen Rippenoberfläche (1c), auf der der eingeschnittene und herausstehende Teil (4) platziert ist, und dem gewellten Abschnitt (5) umfasst, wobei eine Grenzlinie einer unteren Seite des eingeschnittenen und herausstehenden Teils in die gleiche Richtung geneigt ist wie der eingeschnittene und herausstehende Teil.

2. Rippenrohr-Wärmetauscher nach Anspruch 1, wobei der eingeschnittene und herausstehende Teil brückenförmig ausgebildet ist durch ein Paar herausstehende Seiten, die mit der Rippe verbunden sind, und durch ein Paar eingeschnittene und herausstehende Seiten, die von der Rippe getrennt sind,
ein Schlitz zwischen der eingeschnittenen und herausstehenden Seite und der Rippe gebildet ist, und die herausstehende Seite in einer vertikalen Richtung gebildet ist.

3. Rippenrohr-Wärmetauscher nach Anspruch 2, wobei eine der herausstehenden Seiten des eingeschnittenen und herausstehenden Teils, die an einer stromaufwärtigen Seite in Bezug auf den Luftfluss lokalisiert ist, in einer Position ist, die höher ist als eine andere herausstehende Seite, die an der stromabwärtigen Seite im Hinblick auf den Luftfluss lokalisiert ist.

4. Rippenrohr-Wärmetauscher nach Anspruch 2, wobei eine der herausstehenden Seiten des eingeschnittenen und herausstehenden Teils, die an einer stromaufwärtigen Seite in Bezug auf den Luftfluss lokalisiert ist, in einer Position ist, die tiefer ist als eine andere herausstehende Seite, die an der stromabwärtigen Seite im Hinblick auf den Luftfluss lokalisiert ist.

5. Rippenrohr-Wärmetauscher nach Anspruch 1, wobei der eingeschnittene und herausstehende Teil in einer Richtung gebildet wird, die senkrecht zu einer geraden Linie verläuft, die durch das Zentrum des naheliegensten Wärmeübertragungsrohres führt.

6. Rippenrohr-Wärmetauscher nach Anspruch 1, wobei der eingeschnittene und herausstehende Teil parallel zu einer geraden Linie, die durch das Zentrum des Wärmeübertragungsrohres führt, gebildet ist.

7. Rippenrohr-Wärmetauscher nach Anspruch 1, wobei die Rippe einen Rippenkragen umfasst, in den das Wärmeübertragungsrohr eingesetzt ist, und
der eingeschnittene und herausstehende Teil, der gewellte Abschnitt und der Rippenkragen in dieser Reihenfolge in der Größe größer werden.

8. Rippenrohr-Wärmetauscher nach einem der Ansprüche 1 bis 7, wobei wenigstens eine der Rippen, die an einer stromaufwärtigen Seite lokalisiert sind, und eine der Rippen, die auf einer stromabwärtigen Seite lokalisiert sind, in einer Richtung des Luftstroms platziert sind, und
eine Höhe des Wärmeübertragungsrohrs der Rippe auf der stromaufwärtigen Seite und eine Höhe des Wärmeübertragungsrohrs der Rippe auf der stromabwärtigen Seite voneinander unterschiedlich sind.

9. Kühlzyklusvorrichtung umfassend den Rippenrohr-Wärmetauscher nach einem der Ansprüche 1 bis 8.

Revendications

1. Echangeur de chaleur à tubes à ailettes, comprenant une pluralité d'ailettes (1) qui ont des parties coupées et en saillie (4) et à travers lesquelles passe un courant d'air, et
une pluralité de tubes de transfert de chaleur (2) qui pénètrent la pluralité d'ailettes (1) et à travers lesquels circule un fluide, dans lequel
chacune des ailettes (1) comprend un logement plat (6) formé autour du tube de transfert de chaleur (2), une surface plane d'ailette (1c) formée à partir du logement (6) vers une extrémité d'ailette (1d) disposée sur un côté aval par rapport au courant d'air, et une portion ondulée (5) qui présente des sommets et des creux formés alternativement,
les parties coupées et en saillie (4) ne sont placées que sur la surface plane d'ailette (1 c) du côté aval d'un centre du tube de transfert de chaleur le plus proche par rapport au courant d'air,
caractérisé par le fait que ladite portion ondulée (5) est formée autour du logement et autour de la surface plane d'ailette, lesdites parties coupées et en saillie (4) s'inclinent par rapport au courant d'air, et l'échangeur de chaleur à tube à ailettes comprend des lignes limites entre ladite surface plane d'ailette (1c) sur laquelle la partie coupée et en saillie (4) est placée et ladite portion ondulée (5), une ligne limite d'un côté inférieur de la partie coupée et en saillie

étant inclinée dans la même direction que la partie coupée et en saillie.

2. Echangeur de chaleur à tubes à ailettes selon la revendication 1, dans lequel la partie coupée et en saillie est réalisée en forme de pont par une paire de côtés en saillie qui sont reliés à l'ailette et par une paire de côtés coupés et en saillie qui sont séparés de l'ailette,
une fente est formée entre le côté coupé et en saillie et l'ailette, et
le côté en saillie est formé dans une direction verticale.

3. Echangeur de chaleur à tubes à ailettes selon la revendication 2, dans lequel l'un des côtés en saillie de la partie coupée et en saillie qui est situé sur un côté amont par rapport au courant d'air se trouve dans une position supérieure à celle d'un autre côté en saillie qui est situé sur le côté aval par rapport au courant d'air.

4. Echangeur de chaleur à tubes à ailettes selon la revendication 2, dans lequel l'un des côtés en saillie de la partie coupée et en saillie qui est situé sur un côté amont par rapport au courant d'air se trouve dans une position inférieure à celle d'un autre côté en saillie qui est situé sur le côté aval par rapport au courant d'air.

5. Echangeur de chaleur à tubes à ailettes selon la revendication 1, dans lequel la partie coupée et en saillie est formée dans une direction perpendiculaire à une ligne droite passant par le centre du tube de transfert de chaleur le plus proche.

6. Echangeur de chaleur à tubes à ailettes selon la revendication 1, dans lequel la partie coupée et en saillie est formée parallèlement à une ligne droite passant par le centre du tube de transfert de chaleur.

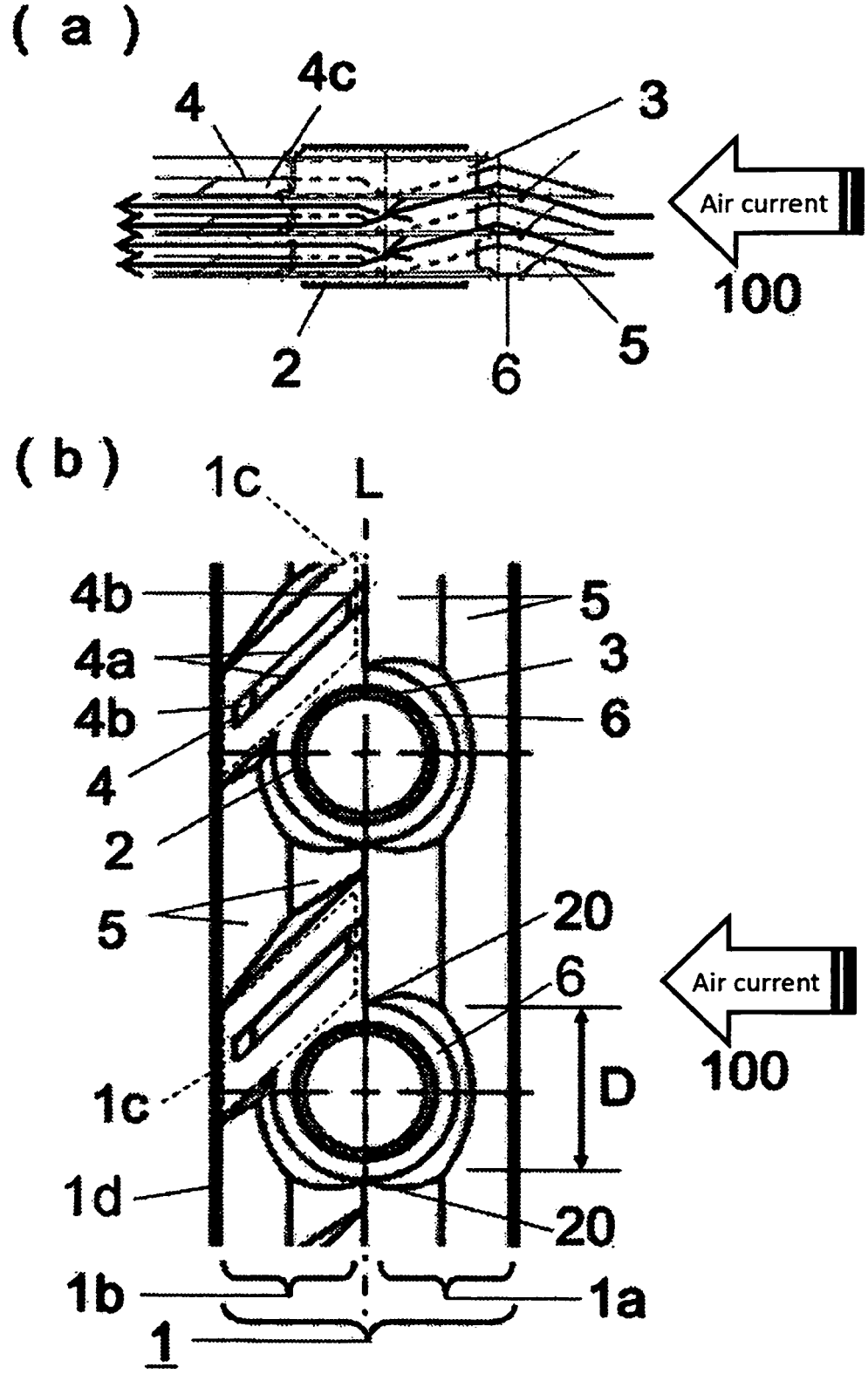
7. Echangeur de chaleur à tubes à ailettes selon la revendication 1, dans lequel l'ailette comprend un collet d'ailette dans lequel le tube de transfert de chaleur est inséré, et
la partie coupée et en saillie, la portion ondulée et le collet d'ailette deviennent plus grands en taille dans cet ordre.

8. Echangeur de chaleur à tubes à ailettes selon l'une quelconque des revendications 1 à 7, dans lequel l'une au moins des ailettes qui sont situées sur un côté amont et l'une des ailettes qui sont situées sur un côté aval sont placées dans une direction du courant d'air, et
une hauteur du tube de transfert de chaleur de l'ailette sur le côté amont et une hauteur du tube de transfert de chaleur de l'ailette sur le côté aval sont différentes l'une de l'autre.

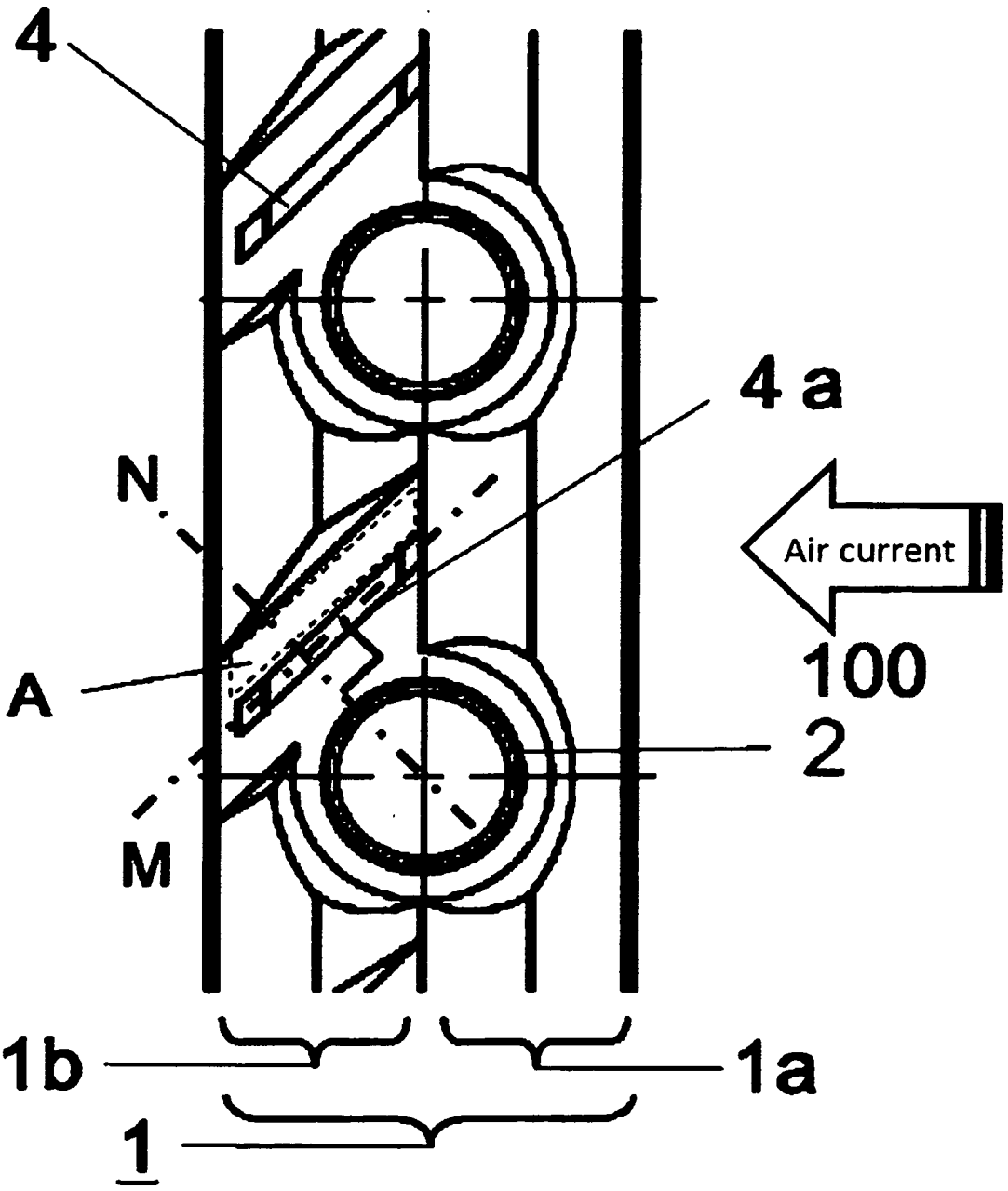
9. Dispositif à cycle frigorifique comprenant l'échangeur de chaleur à tubes à ailettes selon l'une quelconque des revendications 1 à 8.

[NAME OF DOCUMENT] DRAWINGS

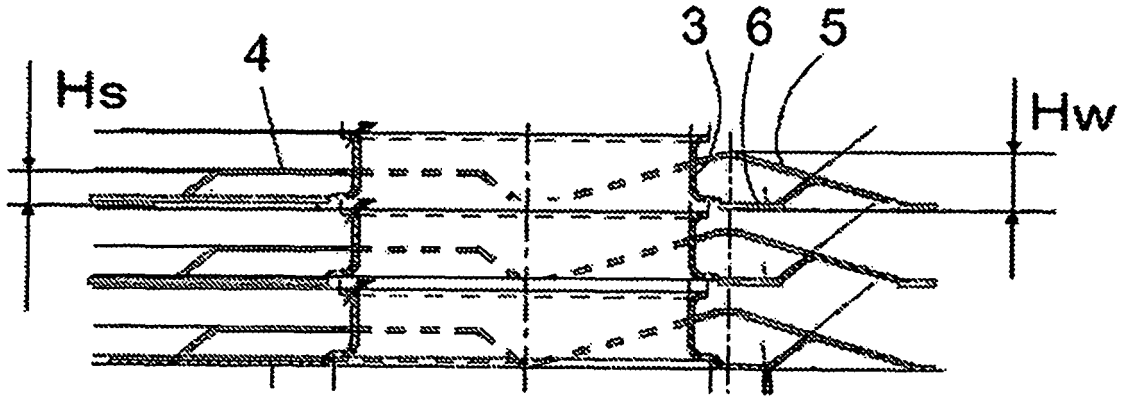
[Fig. 1]



[Fig. 2]

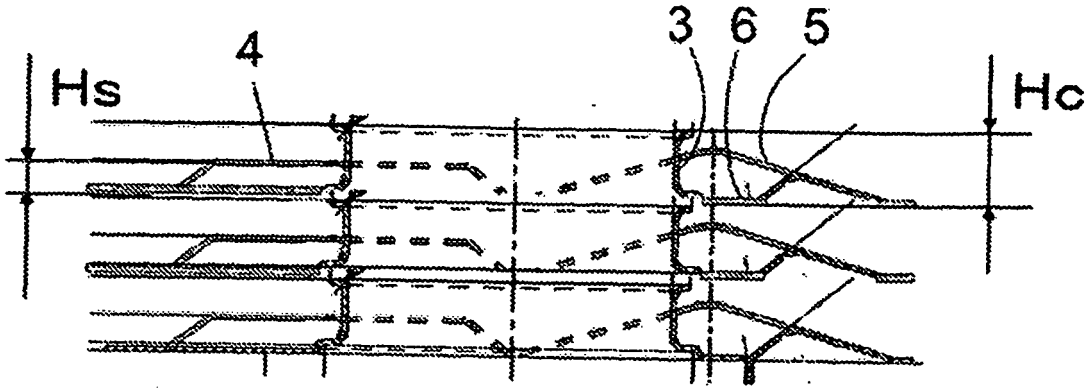


[Fig. 3]



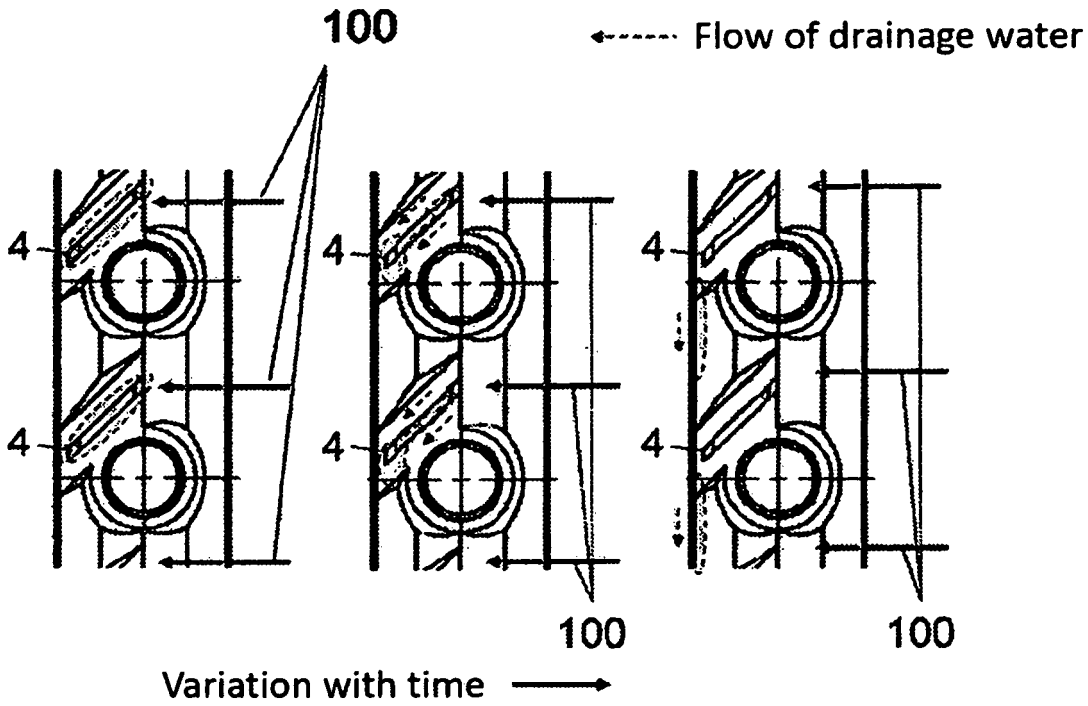
Hw > Hs

[Fig. 4]

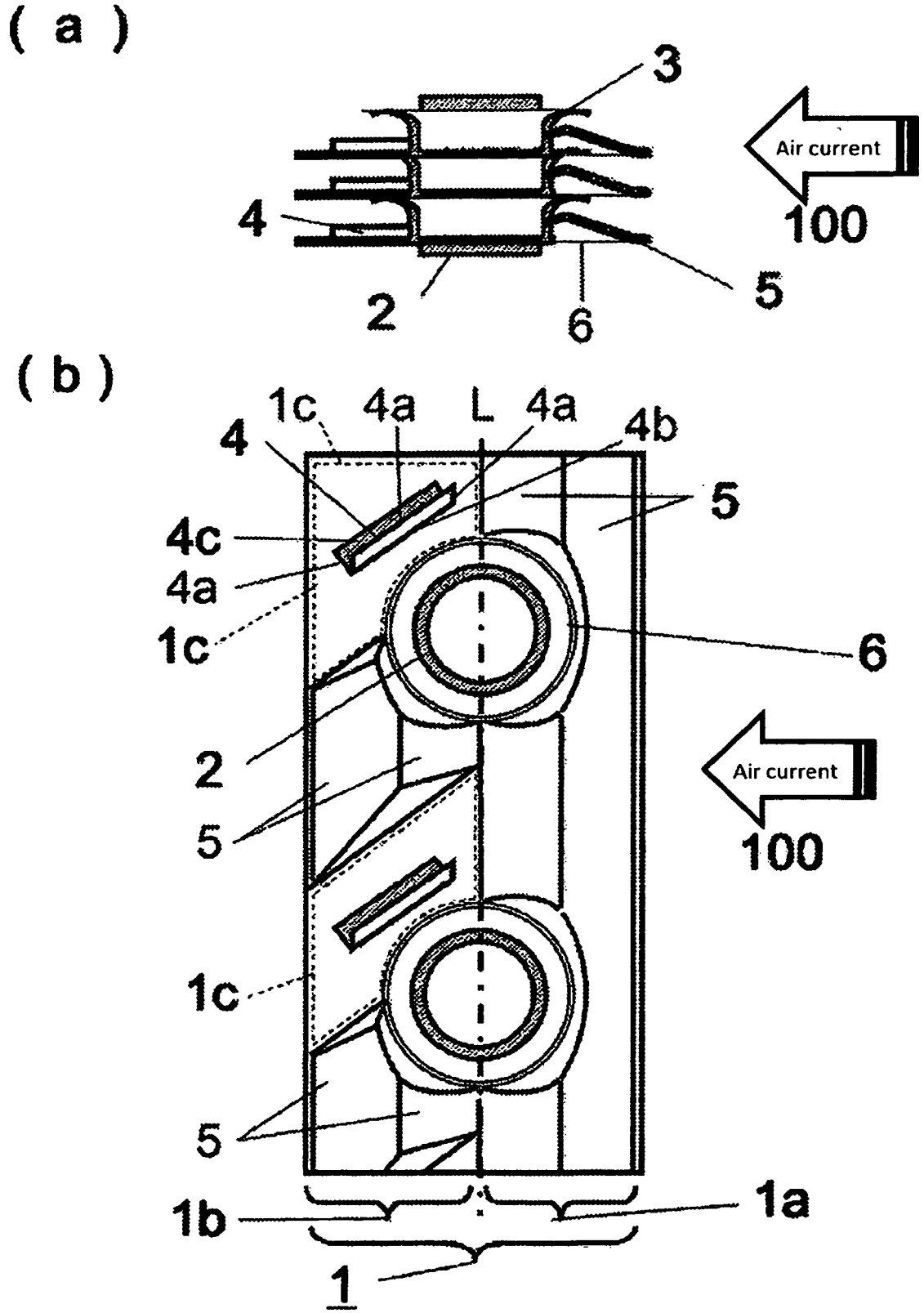


Hc > Hs

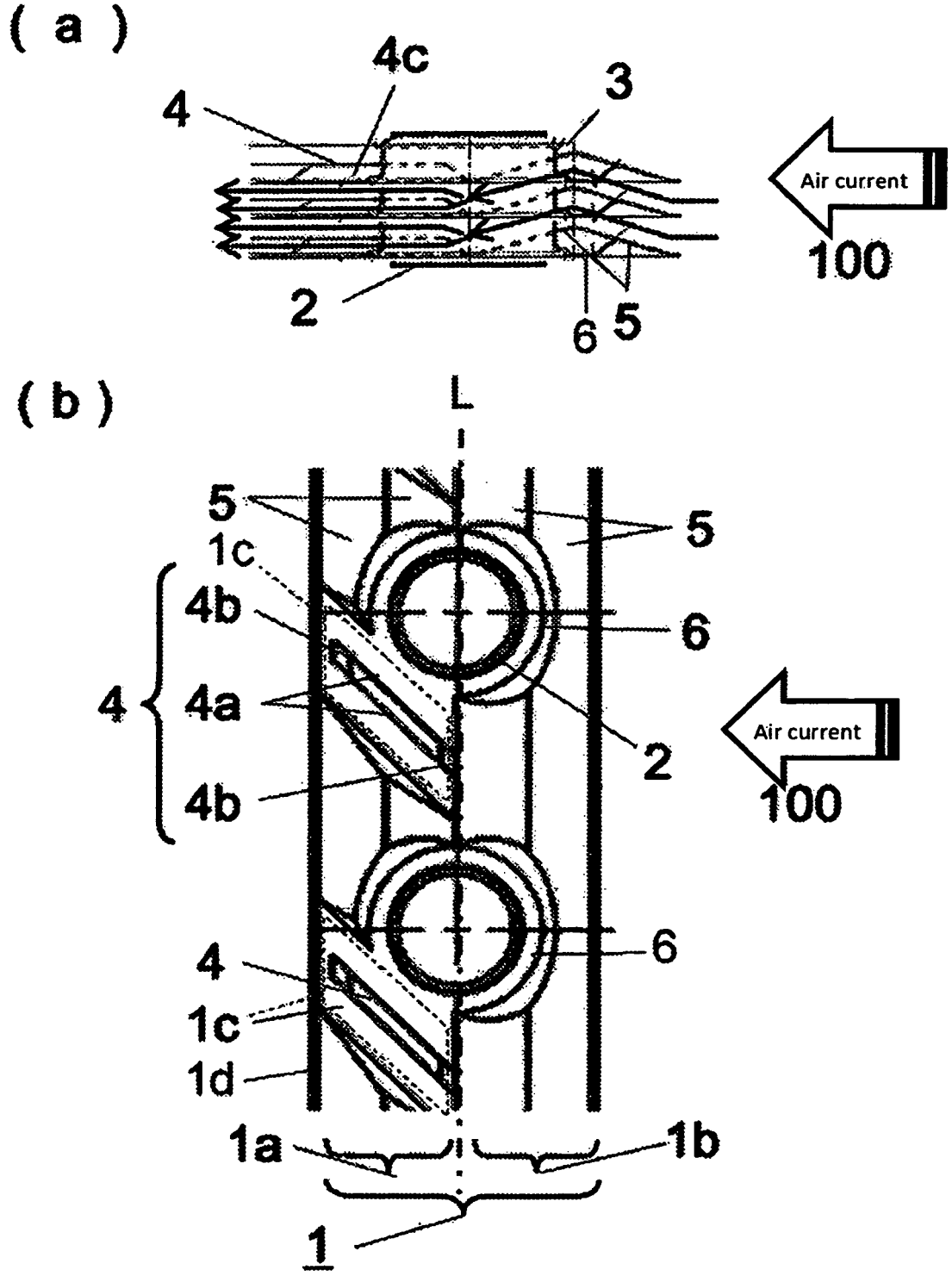
[Fig. 5]


100
Flow of drainage water
4
4
4
4
4
4
100
100
Variation with time

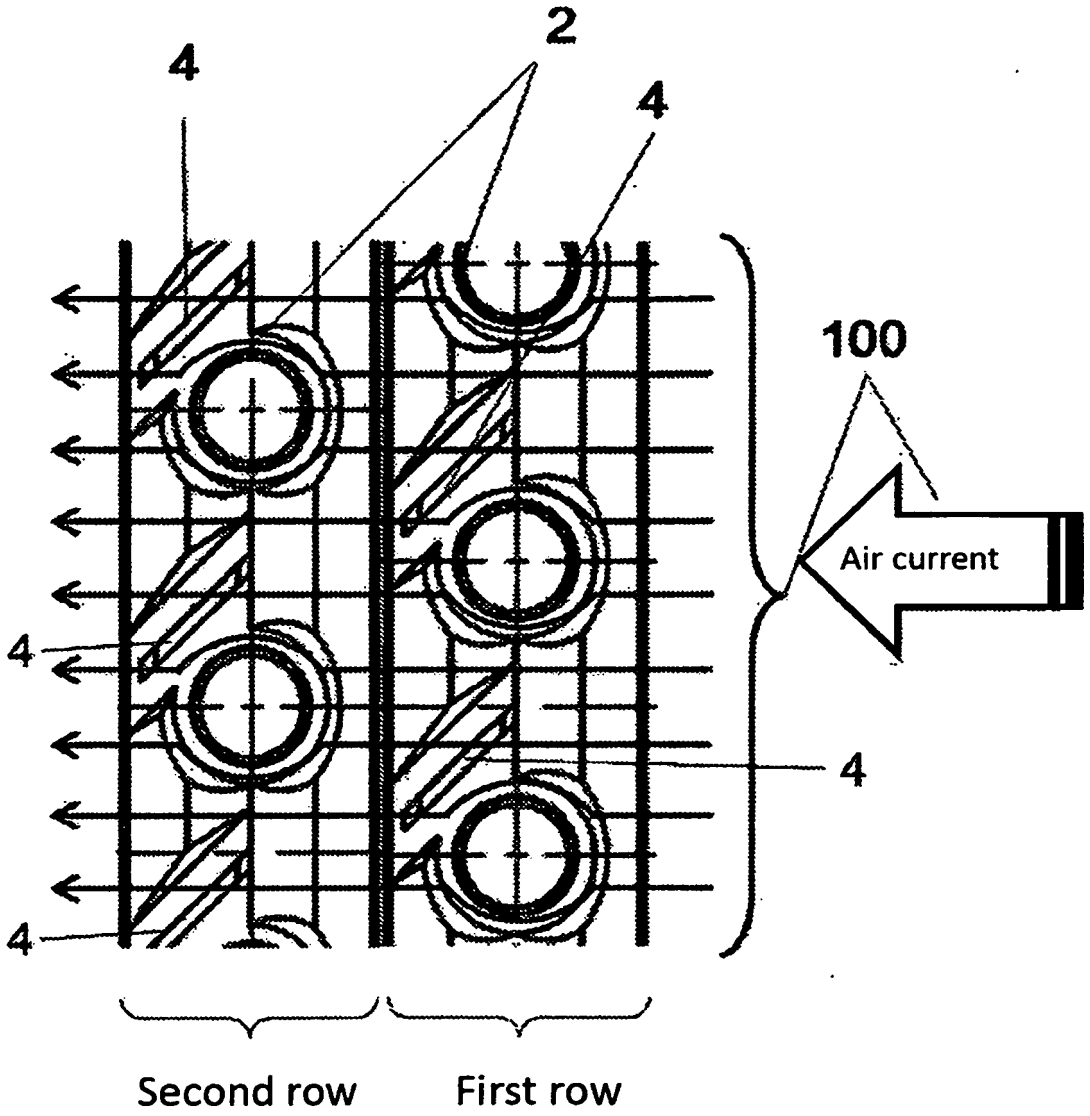
[Fig. 6]


(a)
3
Air current
4
100
2
6
5
(b)
1c
4a
L
4a
4b
4
5
4c
4a
1c
6
2
Air current
5
100
1c
5
1b
1a
1

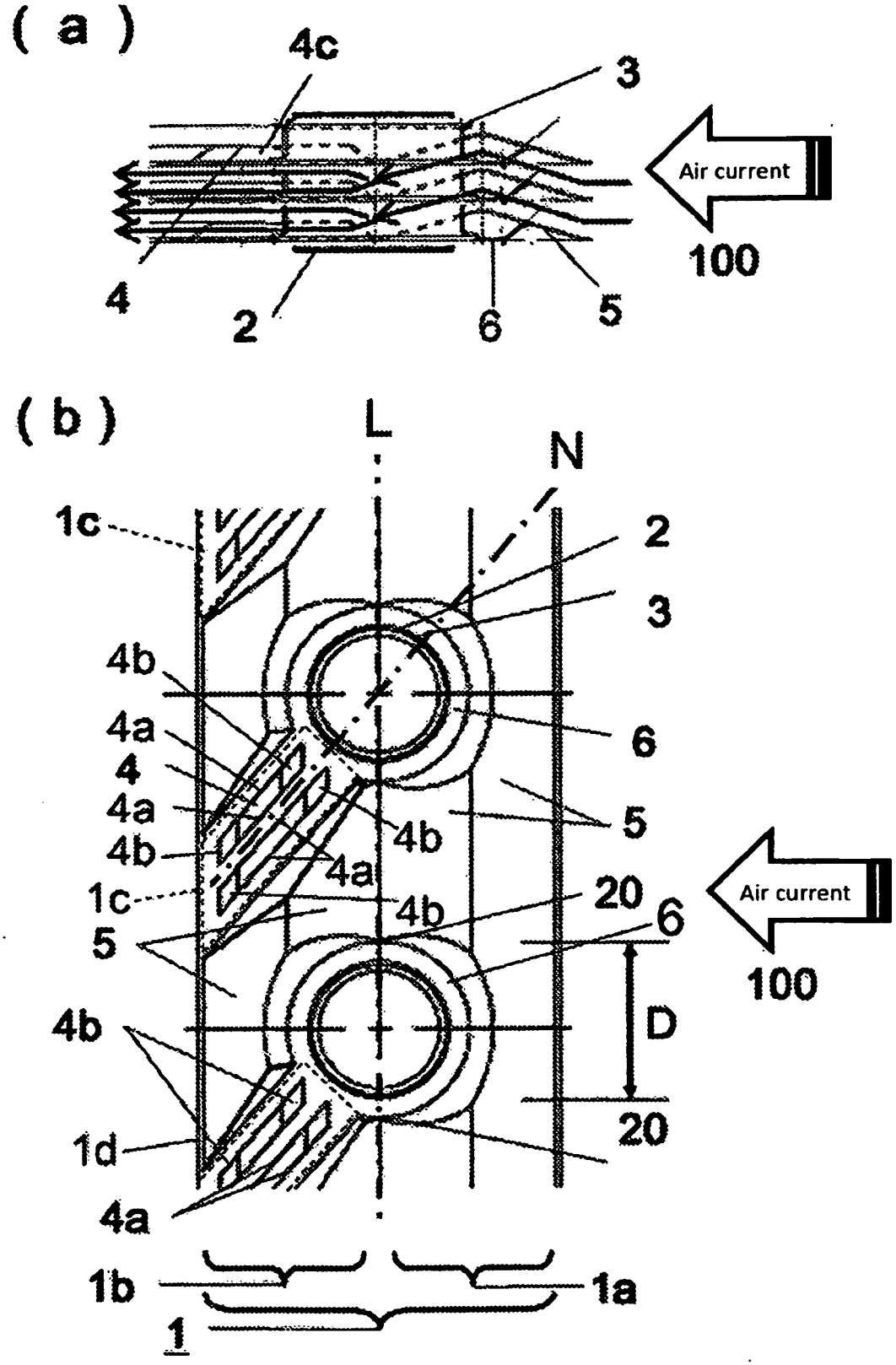
[Fig. 7]


(a)
4c
3
4
Air current
100
2
6
5
(b)
L
5
1c
4b
6
4
4a
2
Air current
100
4b
4
6
1c
1d
1a
1b
1

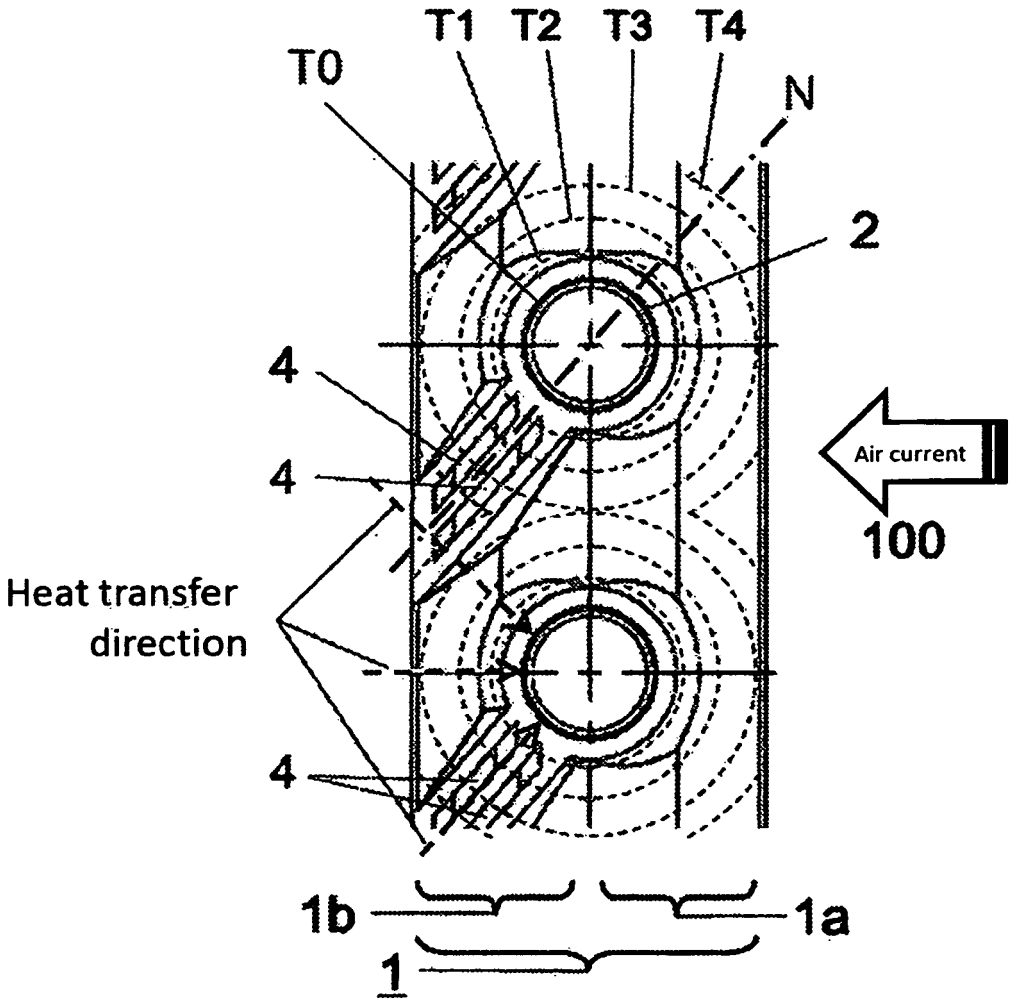
[Fig. 8]



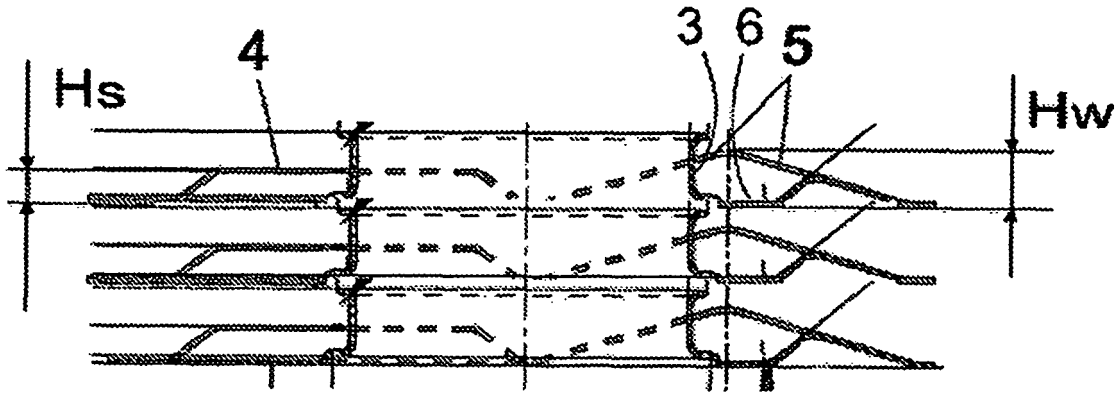
[Fig. 9]


(a)
4c
3
Air current
100
4
2
6
5
(b)
L
N
1c
2
3
4b
4a
4
6
4a
5
4b
4b
4a
1c
4b
20
Air current
5
6
100
D
4b
1d
20
4a
1b
1a
1

[Fig. 10]

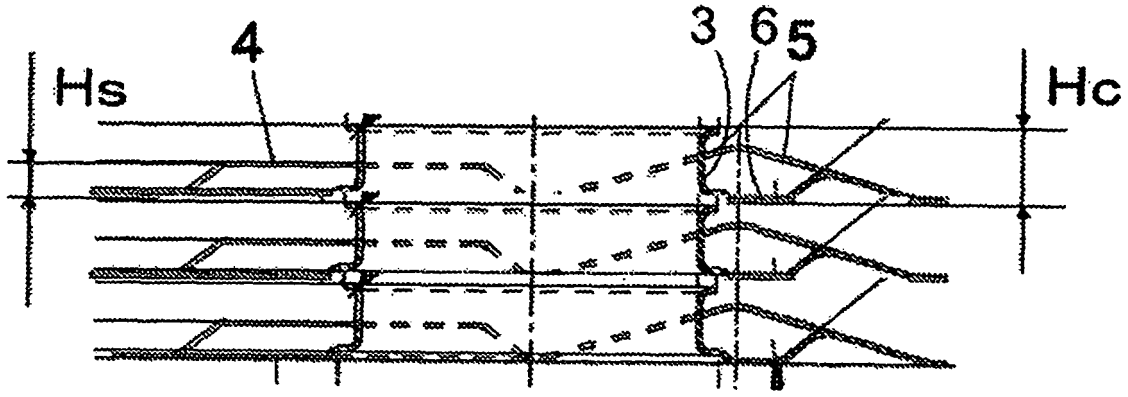

T0
T1
T2
T3
T4
N
2
4
4
4
Heat transfer direction
Air current
100
1b
1a
1

[Fig. 11]



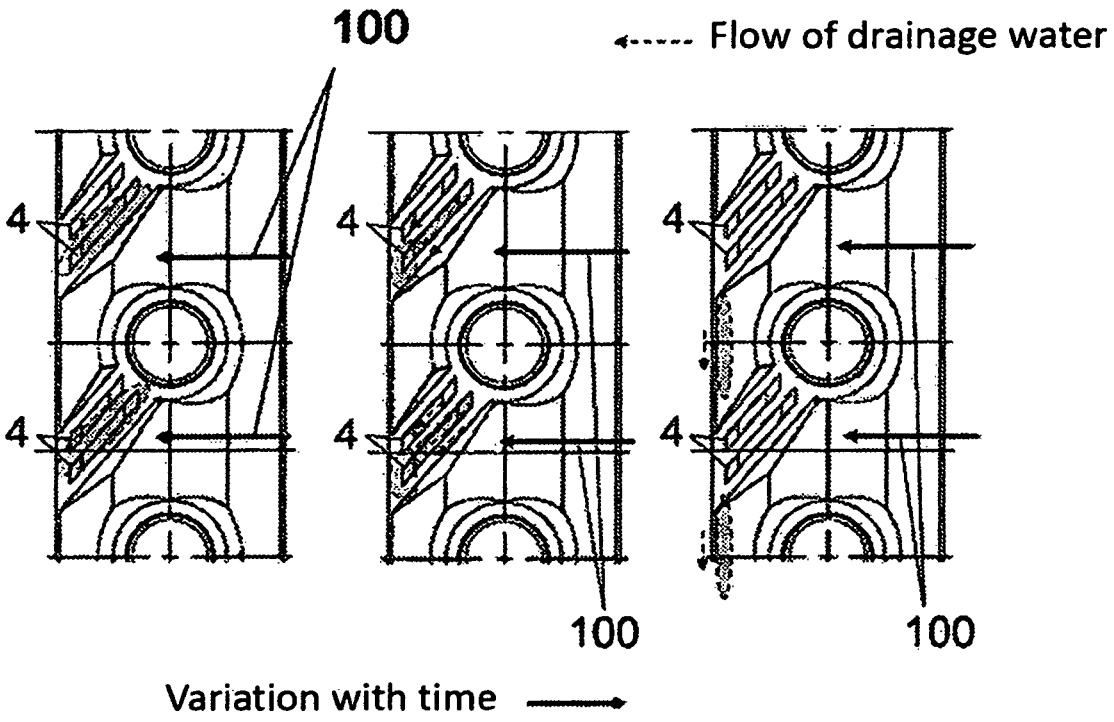
Hw>Hs

[Fig. 12]

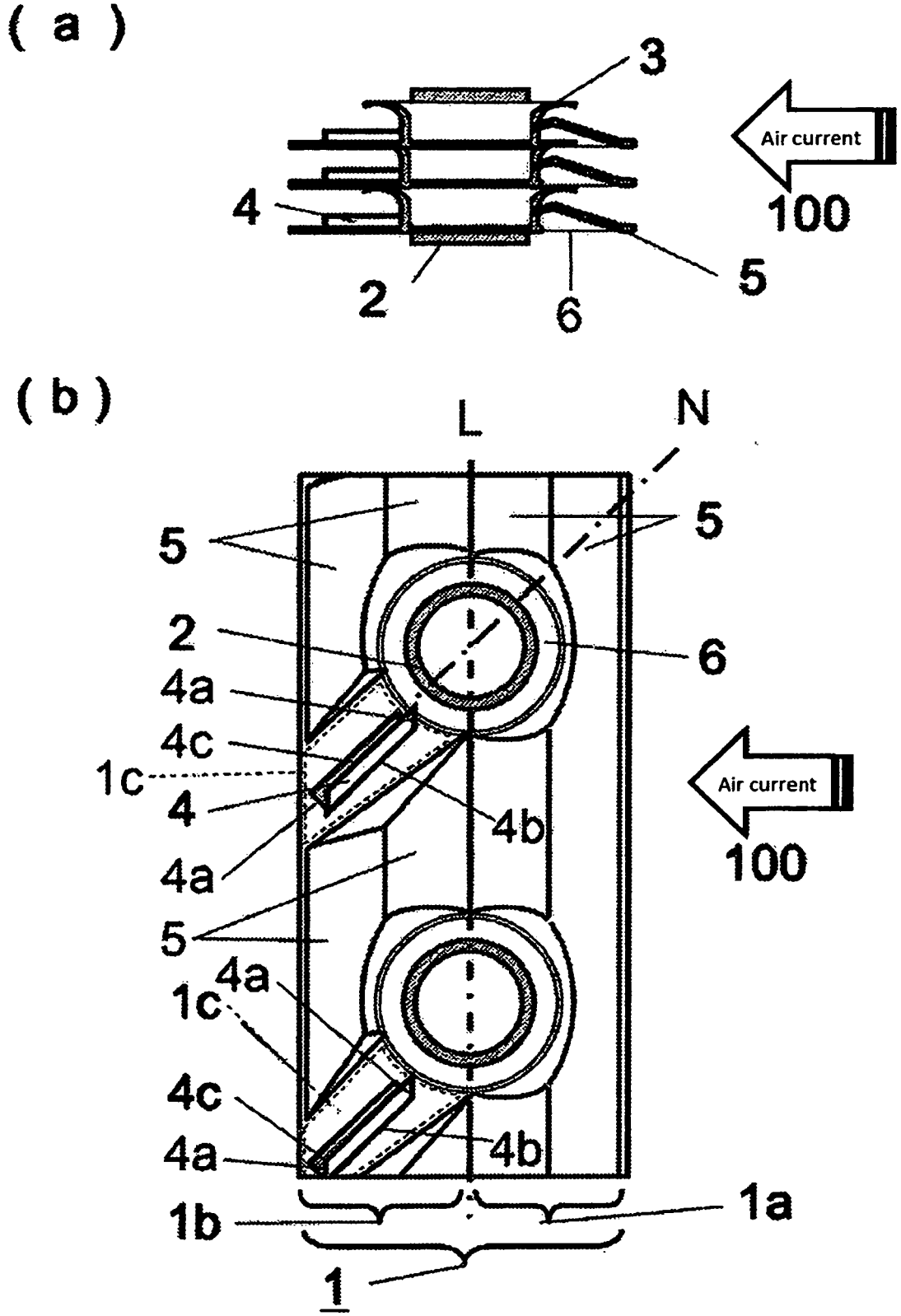


Hc > Hs

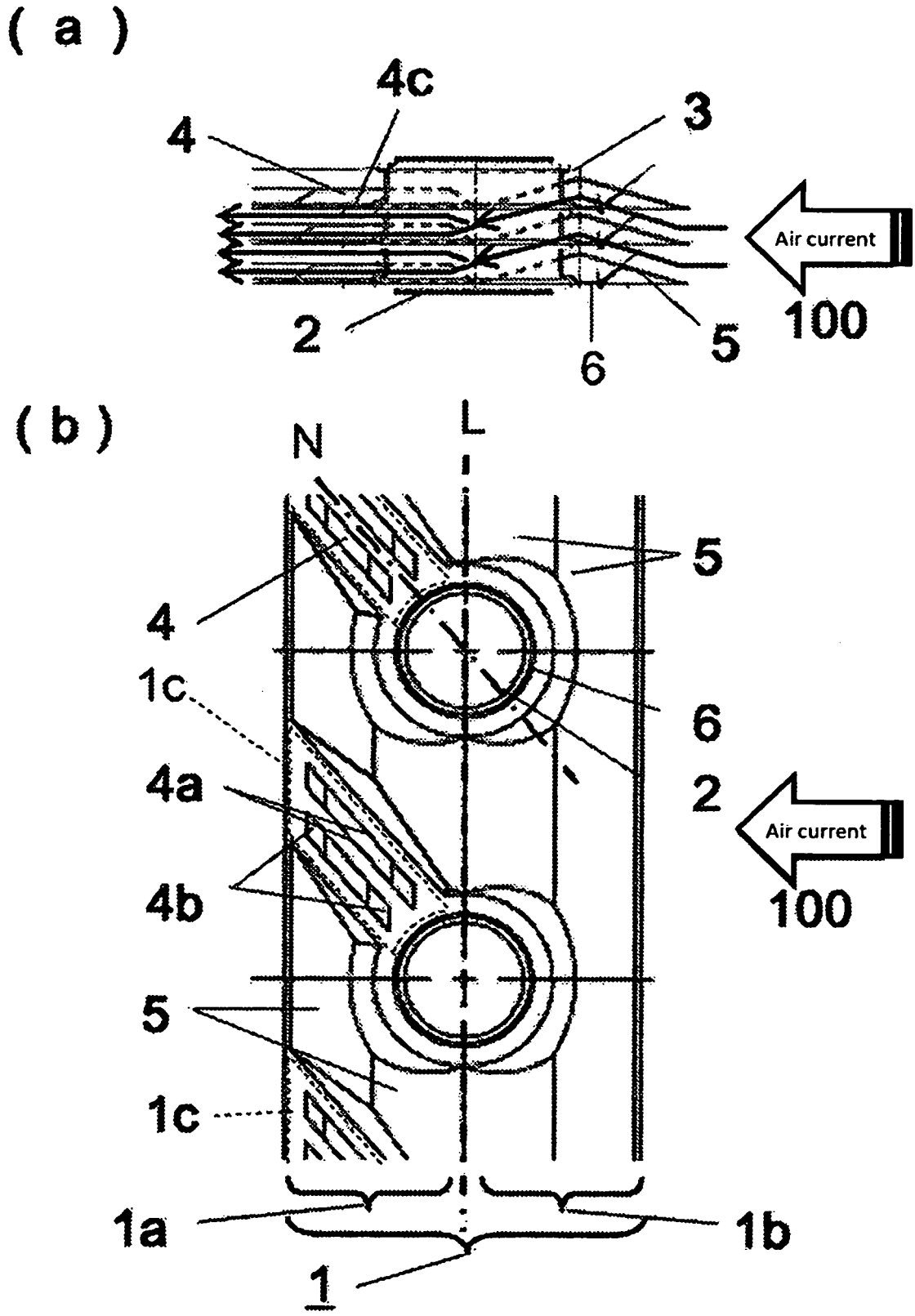
[Fig. 13]


100
Flow of drainage water
4
4
4
4
4
4
100
100
Variation with time

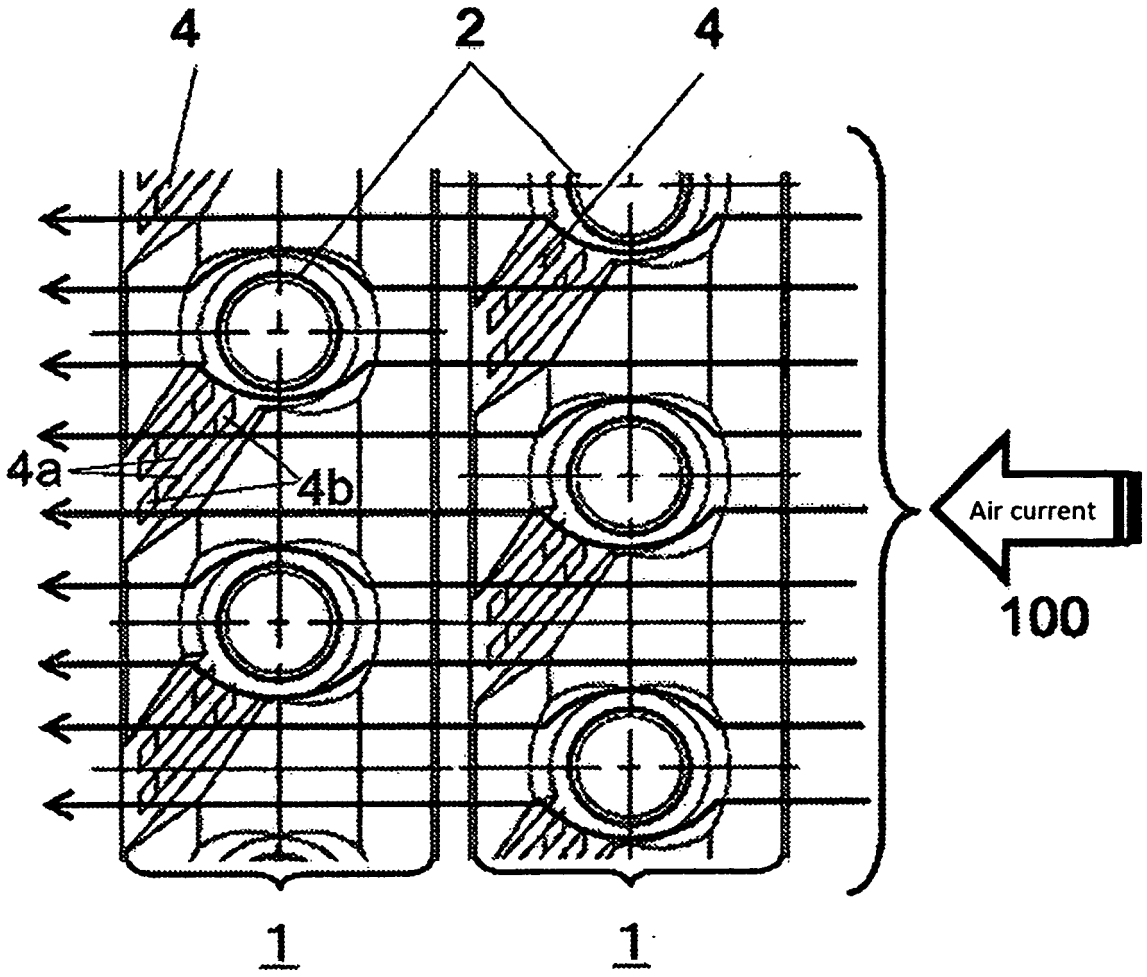
[Fig. 14]


(a)
3
Air current
4
100
2
6
5
(b)
L
N
5
5
2
6
4a
4c
1c
4
Air current
4b
100
4a
5
4a
1c
4c
4b
4a
1b
1a
1

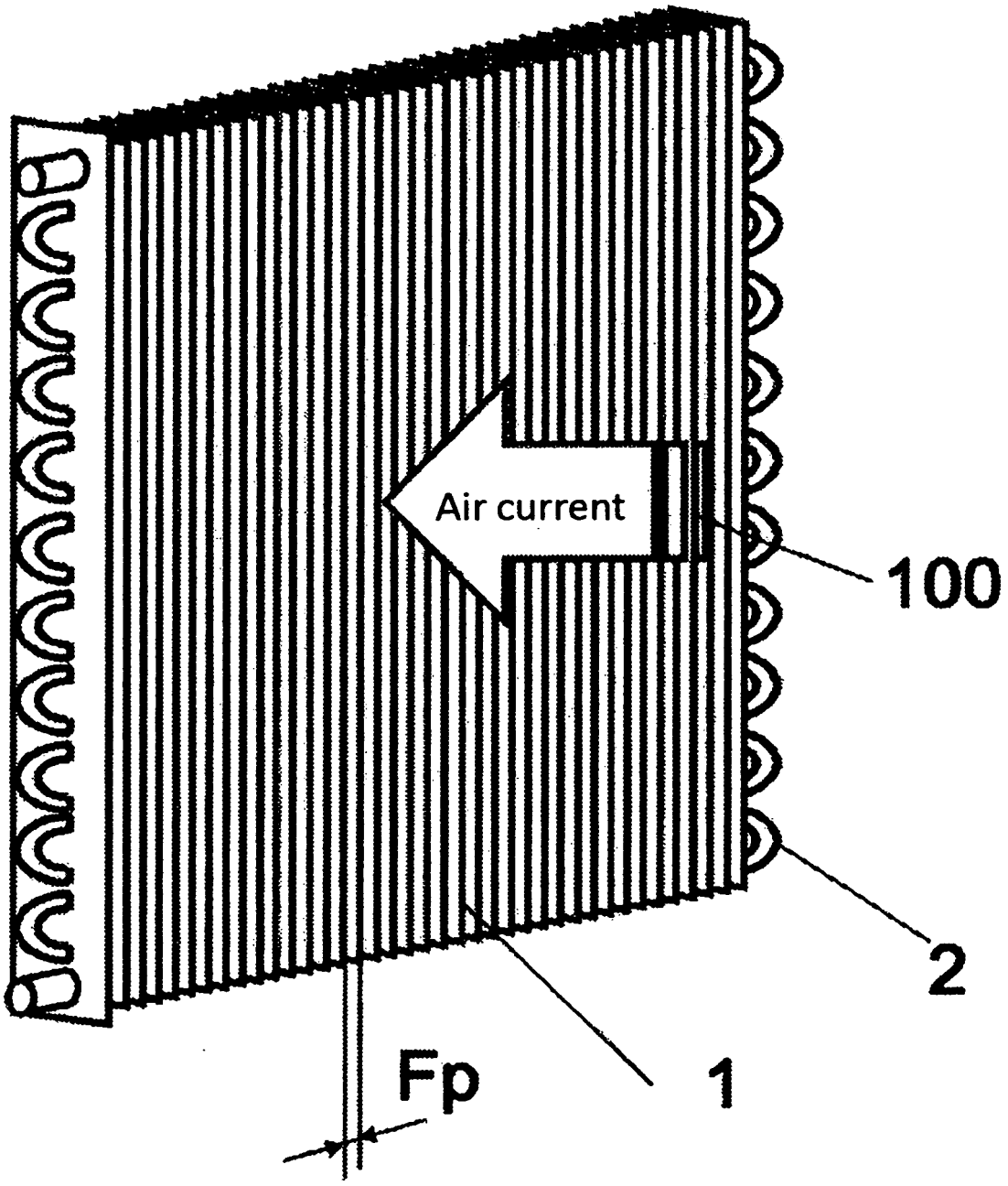
[Fig. 15]


(a)
4c
4
3
Air current
100
2
6
5
(b)
N
L
5
4
1c
6
4a
2
Air current
100
4b
5
1c
1a
1b
1

[Fig. 16]

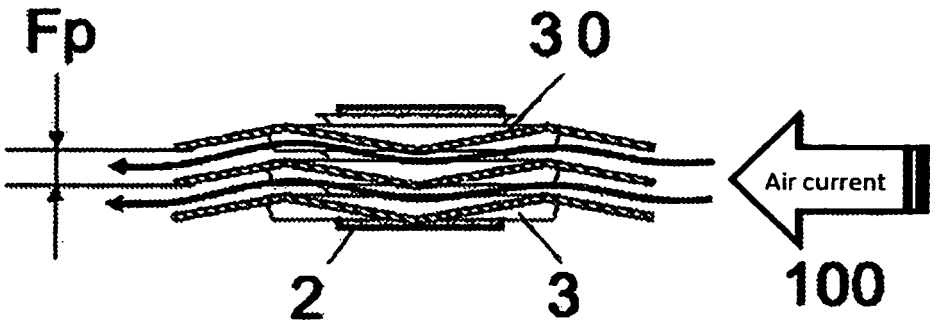


[Fig. 17]



[Fig. 18]

(a)



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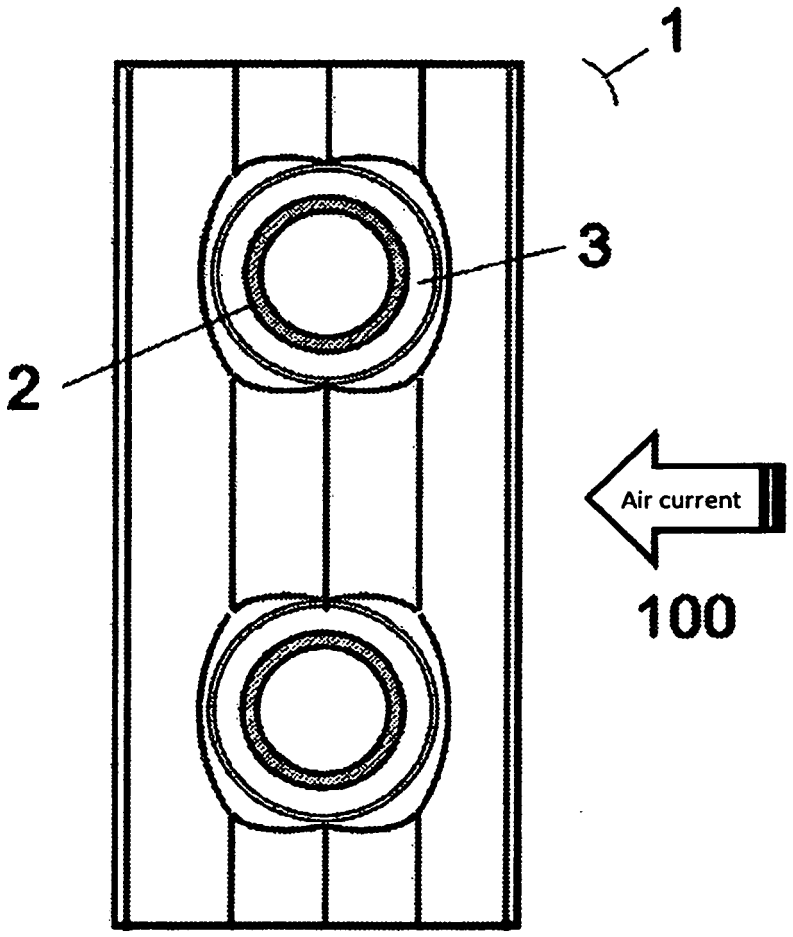
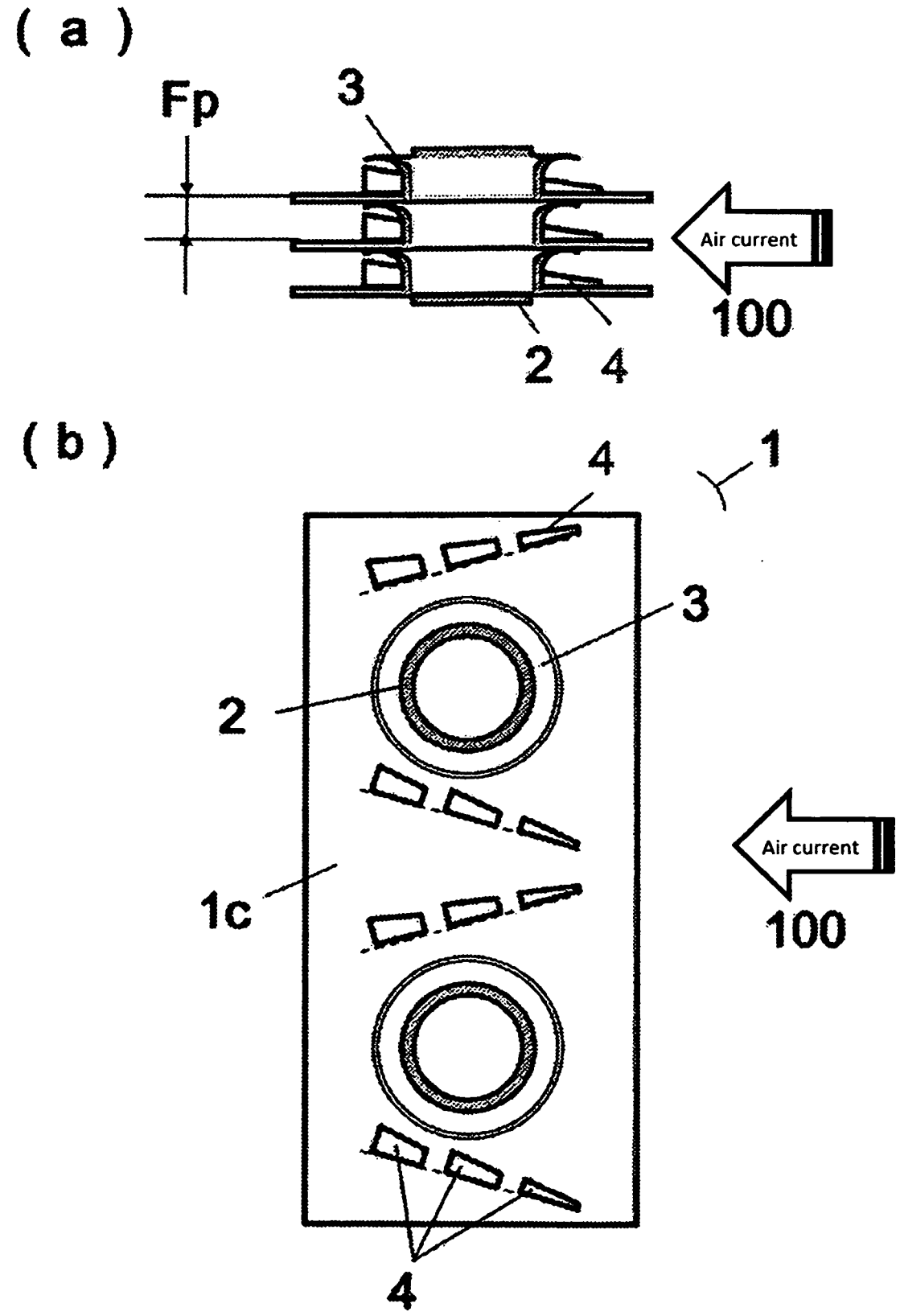
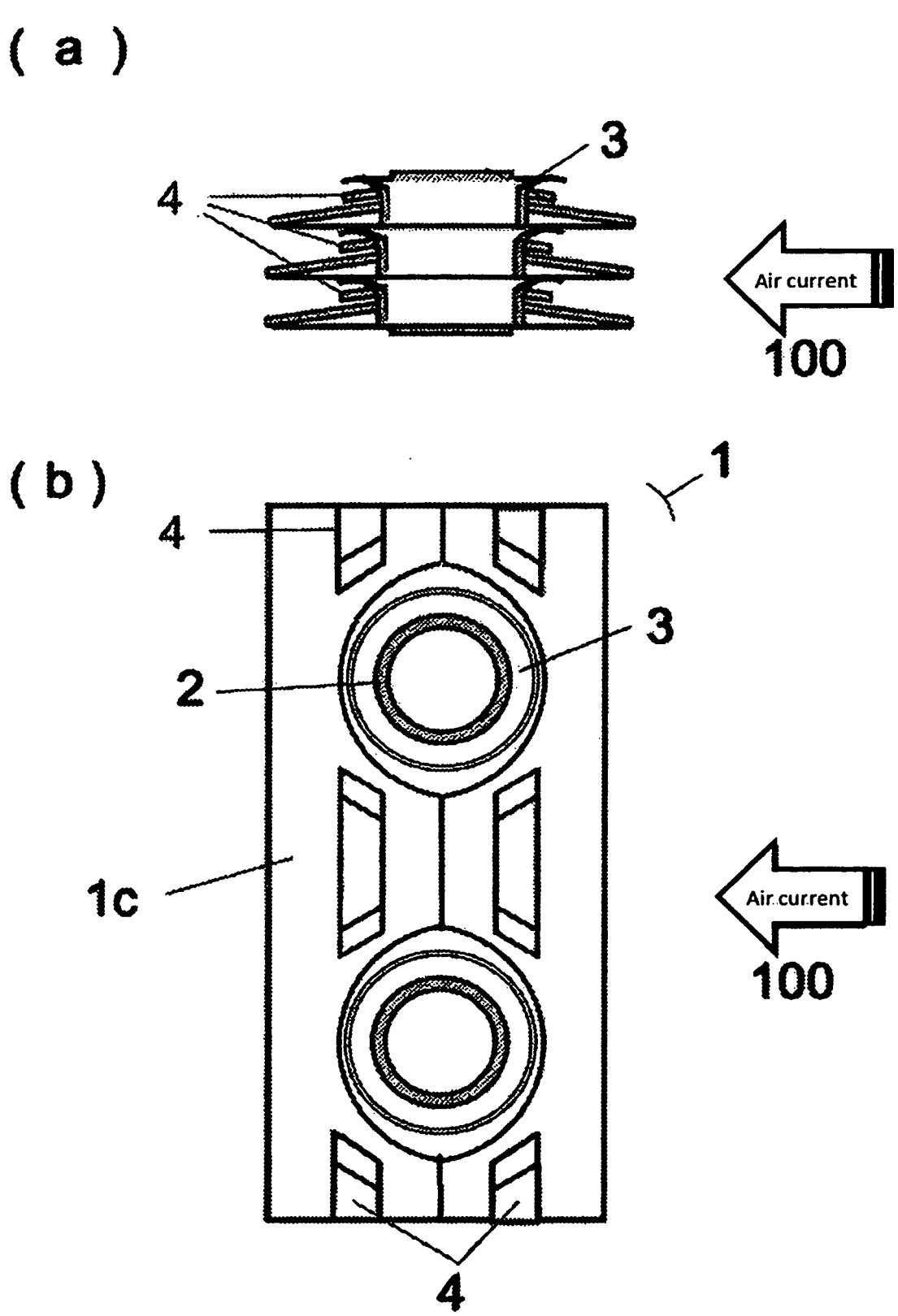


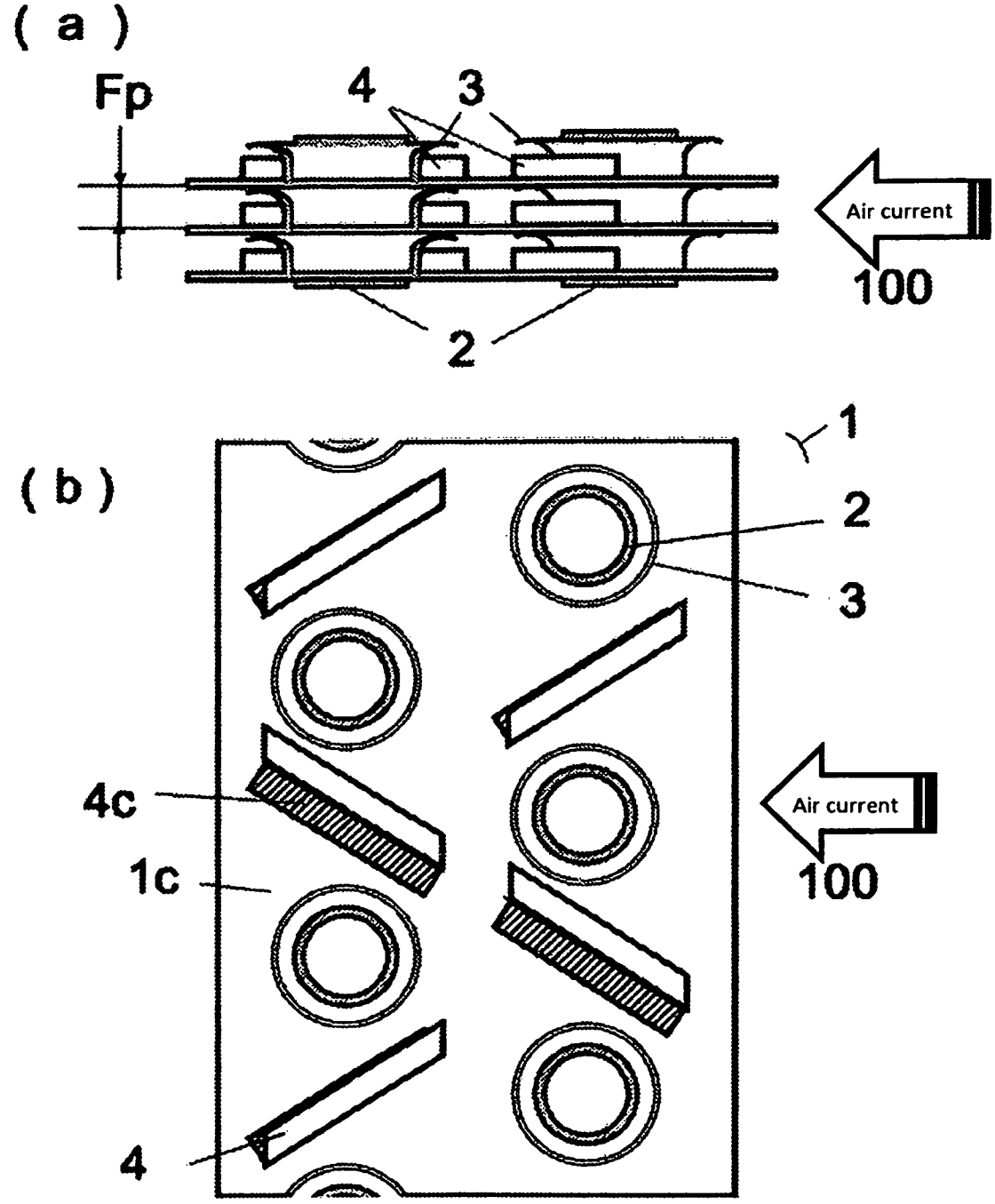
[Fig. 19]



[Fig. 20]



[Fig. 21]



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2001091101 A **[0015]**
- JP 2008089237 A **[0016]**
- JP H11125495 B **[0016]**
- JP 2007309533 A **[0016]**