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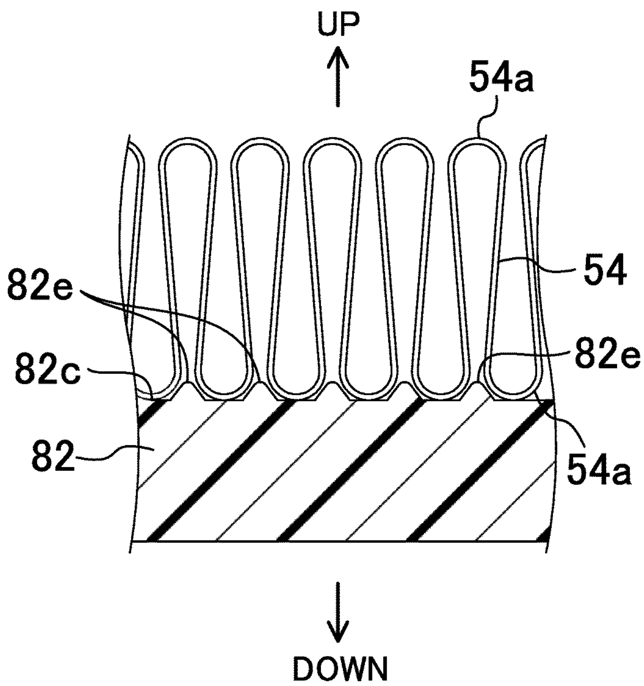
(54) **ELECTRIC HEATER OF AIR CONDITIONER FOR VEHICLE**

(57) A holding frame accommodates and holds a heating body, fins 54, and a spring member in a stacked manner. On the holding frame, projections 82e configured to engage with crests 54a of a fin 54 disposed in an end portion inside the holding frame in the stacking direction are formed.

FIG. 8



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Description

TECHNICAL FIELD

[0001] The present invention relates to a structure of an electric heater provided to an air conditioner for a vehicle that is installed in an automobile, for example, and particularly belongs to a technical field for a structure including a fin that transmits heat generated by a heating body supplied with electric power to air to be air-conditioned.

BACKGROUND ART

[0002] Conventionally, there have been cases in which an electric heater configured to heat air to be air-conditioned is provided to an air conditioner for a vehicle, for example (see Patent Documents 1 and 2, for example). Such an electric heater includes: PTC elements and fins for dissipating heat that are stacked; and a spring element for compressing the PTC elements and the fins in the stacking direction. The PTC elements, the fins, and the spring element are held by a housing frame in a stacked manner.

[0003] In each of Patent Documents 1 and 2, a plurality of struts are provided that extend from an upper-peripheral portion of the housing frame to a lower-peripheral portion thereof to connect between the upper-peripheral portion and the lower-peripheral portion. The struts extend straight in the vertical direction, and are disposed in an evenly spaced manner in the width direction of the housing frame. Air to be air-conditioned passes through inside of the housing frame, and is heated by heat of the PTC elements while passing through the fins.

[0004] The housing frame in each of Patent Documents 1 and 2 includes an upper housing and a lower housing that are split into two in the flow direction of outside air. When the electric heater in each of Patent Documents 1 and 2 is manufactured, the PTC elements and the fins are stacked to be assembled in advance to the upper housing first in a stacked manner. In this state, when the lower housing is assembled to the upper housing, the spring element is pushed into the upper housing, whereby compression force is applied to the PTC elements and the fins in the stacking direction. By assembling the lower housing to the upper housing, the PTC elements and the fins are held from both sides in the flow direction of outside air.

CITATION LIST

PATENT DOCUMENT

[0005]

PATENT DOCUMENT 1: Japanese Patent No. 4880648
PATENT DOCUMENT 2: Japanese Patent No. 4939490

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0006] When the spring element is provided as in Patent Documents 1 and 2, the fins are compressed by the spring element in the stacking direction, and a fin to which the compression force is applied may deform in a direction in which the distance between adjacent crests of the fin, that is, the fin pitch thereof deviates from its design value because the fin is formed of a thin sheet. When the fin pitch deviates from the design value, the airflow resistance deteriorates, which causes the heating performance of the electric heater to decrease.

[0007] In view of this, a structure is considered in which a plate member for connecting adjacent crests is soldered to the fin so as to keep the fin pitch from deviating even when compression force of the spring element is applied to the fin. However, when such a structure is used, the number of components increases, whereby the cost is increased, and also the dimensional tolerance of the fin in the height direction is increased. Consequently, it may be difficult to set the compression force of the spring element within an appropriate range.

[0008] The present invention has been made in view of the foregoing, and it is an object thereof to keep the fin pitch from deviating while keeping the cost from increasing, and to increase the heating performance of the electric heater.

SOLUTION TO THE PROBLEM

[0009] To achieve the above-described object, in the present invention, an engagement portion configured to engage with crests of a fin is formed.

[0010] A first aspect of the present invention is directed to an electric heater of an air conditioner for a vehicle. The electric heater includes: a heating body configured to generate heat when being supplied with electric power; corrugated fins arranged in a manner stacked on the heating body; a spring member configured to apply compression force to the heating body and the fins in a stacking direction; and a holding frame configured to accommodate and hold the heating body, the fins, and the spring member in a stacked manner. Air to be air-conditioned blown into the holding frame is heated when passing through the fins. A fin of the fins is disposed so as to be positioned in an end portion of the electric heater in the stacking direction. On the holding frame, a frame engagement portion configured to engage with crests of the fin disposed in the end portion in the stacking direction is formed.

[0011] By this configuration, while the heating body, the fins, and the spring member are held by the holding frame, compression force in the stacking direction is applied to the fins by the spring member. At this time, the frame engagement portion of the holding frame engages with the crests of the fin disposed in the end portion in the stacking direction, and thus the crests of the fin are less likely to be displaced. In other words, without soldering a plate member to the fin, the fin pitch is less likely to deviate from the design value, and thus the airflow resistance is kept appropriate.

[0012] A second aspect of the present invention is an embodiment of the first aspect. In the second aspect, the holding frame has a contact surface with which the fin disposed in the end portion in the stacking direction is brought into contact, and the frame engagement portion is a projection protruding from the contact surface and disposed between adjacent crests of the fin.

[0013] By this configuration, the projection formed on the contact surface, with which the fin is brought into contact, of the holding frame is disposed between the adjacent crests of the fin, and thus the crests are still less likely to be displaced, and the airflow resistance can be kept appropriate.

[0014] A third aspect of the present invention is an embodiment of the second aspect. In the third aspect, an insulating plate is interposed between the fins stacked in the stacking direction, and a plate engagement portion configured to engage with crests of each fin is formed on the insulating plate.

[0015] By this configuration, the plate engagement portion formed on the insulating plate disposed between the fins engages with the crests of each fin, and thus the crests of the fin are less likely to be displaced.

[0016] A fourth aspect of the present invention is an embodiment of the third aspect. In the fourth aspect, the plate engagement portion is a projection protruding from the insulating plate and disposed between adjacent crests of each fin.

[0017] By this configuration, the projection formed on the insulating plate is disposed between the adjacent crests of the fin, and thus the crests are still less likely to be displaced, and the airflow resistance can be kept appropriate.

[0018] A fifth aspect of the present invention is directed to an electric heater of an air conditioner for a vehicle. The electric heater includes: a heating body configured to generate heat when being supplied with electric power; corrugated fins arranged in a manner stacked on the heating body; a spring member configured to apply compression force to the heating body and the fins in a stacking direction; an insulating plate interposed between the fins stacked in the stacking direction; and a holding frame configured to accommodate and hold the heating body, the fins, the spring member, and the insulating plate in a stacked manner. Air to be air-conditioned blown into the holding frame is heated when passing through the fins. On the insulating plate, a plate engagement portion configured to engage crests of each fin is formed.

[0019] By this configuration, while the heating body, the fins, the spring member, and the insulating plate are held by the holding frame, compression force in the stacking direction is applied to the fins by the spring member. At this time, the plate engagement portion of the insulating plate engages with the crests of each fin, and thus the crests of the fin are less likely to be displaced. In other words, without soldering a plate member to the fin, the fin pitch is less likely to be deviate from the design value, and thus the airflow resistance is kept appropriate.

ADVANTAGES OF THE INVENTION

[0020] According to the first aspect, the frame engagement portion formed on the holding frame is engaged with crests of the corresponding fin, and thus it is possible to keep the fin pitch from deviating while keeping the cost from increasing, and to increase the heating performance of the electric heater.

[0021] According to the second aspect, the projection formed on the contact surface, with which the corresponding fin is brought into contact, of the holding frame is disposed between adjacent crests of the fin, and thus the crests are less likely to be displaced.

[0022] According to the third aspect, on the insulating plate disposed between the fins, the plate engagement portion configured to engage with crests of each fin is formed, and thus the pitch of a fin positioned in an intermediate portion of the electric heater in the stacking direction can be kept from deviating.

[0023] According to the fourth aspect, the projection formed on the insulating plate is disposed between adjacent crests of the corresponding fin, and thus the crests are still less likely to be displaced.

[0024] According to the fifth aspect, on the insulating plate interposed between the fins stacked in the stacking direction, the plate engagement portion configured to engage with crests of each fin is formed, and thus it is possible to keep the fin pitch from deviating while keeping the cost from increasing, and to increase the heating performance of the electric heater.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

FIG. 1 is a perspective view of an electric heater of an air conditioner for a vehicle according to a first embodiment when viewed from an upstream side in the flow direction of air to be air-conditioned.

FIG. 2 is a perspective view of the electric heater from which an upstream frame-forming member and left and right cap members are removed.

FIG. 3 is a perspective view illustrating an upper portion of the electric heater and its vicinity in FIG. 2 in an enlarged manner.

FIG. 4 is a sectional view taken along line IV-IV in FIG. 2.

FIG. 5 is a sectional view taken along line V-V in FIG. 1.

FIG. 6 is a sectional view taken along line VI-VI in

FIG. 2.

FIG. 7 is a perspective view of a downstream lower-peripheral portion of a downstream frame-forming member from which a fin is separated upward.

FIG. 8 is a diagram illustrating lower part of FIG. 6 in an enlarged manner.

FIG. 9 is a perspective view illustrating a lower insulating plate from which fins are separated each upward and downward.

DESCRIPTION OF EMBODIMENTS

[0026] Embodiments of the present invention will now be described in detail with reference to the drawings. It should be noted that the following description of the preferred embodiments is merely illustrative in nature, and is not intended to limit the scope, applications, or use of the present invention.

[0027] FIG. 1 is a diagram illustrating an electric heater 1 in an air conditioner for a vehicle according to a first embodiment of the present invention. This electric heater 1 is a heater arranged inside the air conditioner for a vehicle (not depicted) and configured to heat air to be air-conditioned introduced from outside of a vehicle cabin or inside of the vehicle cabin into the air conditioner for a vehicle. Herein, the air conditioner for a vehicle is installed inside an instrument panel (not depicted) in a vehicle cabin of an automobile, for example, so as to be able to adjust the temperature of air to be air-conditioned to supply the air to various areas in the vehicle cabin. Specifically, although not depicted, the air conditioner for a vehicle includes a casing, a blower fan, a cooling heat exchanger, and the electric heater. The blower fan and the cooling heat exchanger are accommodated in the casing. The blower fan is a component configured to send air to be air-conditioned. The cooling heat exchanger is a component configured to cool the air to be air-conditioned. The electric heater 1 is a component disposed in an area in the casing downstream of the cooling heat exchanger in the flow direction of air to be air-conditioned, and configured to heat the air to be air-conditioned. In the casing, an air mix damper is arranged. The air mix damper is a component configured to change the amount of air passing through the electric heater 1 thereby changing the temperature of air-conditioned air. Furthermore, in the casing, airflow mode dampers including a defroster-mode damper, a ventilation-mode damper, and a heat-mode damper are arranged. The defroster damper is a component configured to change the amount of air-conditioned air to be blown toward an inner surface of a windshield (not depicted), the vent damper is a component configured to change the amount of air-conditioned air to be blown toward the upper body of a passenger, and the heat damper is a component configured to change the amount of air-conditioned air to be blown toward the vicinity of feet of the passenger. Herein, the structure of the air conditioner for a vehicle is not limited to the above-described structure.

[0028] The electric heater 1 includes an upper heating body 50, a central first heating body 51, a central second heating body 52, a lower heating body 53, a plurality of fins 54, an upper spring member (one-side spring member) 55, and a holding frame 60, and has a rectangular shape that is laterally long as a whole when viewed from the flow direction of air to be air-conditioned. The upper heating body 50, the central first heating body 51, the central second heating body 52, and the lower heating body 53 have the same structure including a plurality of PTC elements (not depicted) configured to generate heat when being supplied with electric power from a battery (not depicted), for example, mounted on the vehicle, and having a plate-like shape that is laterally long. In each of the upper heating body 50, the central first heating body 51, the central second heating body 52, and the lower heating body 53, the PTC elements are disposed so as to be laterally aligned.

[0029] In the description of the present embodiment, the upstream side and the downstream side in the flow direction of air to be air-conditioned are defined as depicted in FIG. 4. However, the air to be air-conditioned may be allowed to flow in the direction opposite to that of this definition. The left side and the right side of the electric heater 1 are defined as depicted in the respective drawings, and may correspond to the left side and the right side of the vehicle, but do not have to correspond thereto. The upper side and the lower side of the electric heater 1 are defined as depicted in the respective drawings, and may correspond to the upper side and the lower side of the vehicle, but do not have to correspond thereto.

[0030] As depicted also in FIG. 2, the upper heating body 50 is disposed in an upper portion of the electric heater 1. On the right end of the upper heating body 50, electrode plates 50a to be connected to the corresponding PTC elements are provided so as to protrude rightward. The central first heating body 51 is disposed in a vertically central portion of the electric heater 1 closer to the upper side thereof. On the right end of the central first heating body 51, electrode plates 51a to be connected to the corresponding PTC elements are provided so as to protrude rightward. The central second heating body 52 is disposed in a vertically central portion of the electric heater 1 closer to the lower side thereof. On the right end of the central second heating body 52, electrode plates 52a to be connected to the corresponding PTC elements are provided so as to protrude rightward. The lower heating body 53 is disposed in a lower portion of the electric heater 1. On the right end of the lower heating body 53, electrode plates 53a to be connected to the corresponding PTC elements are provided so as to protrude rightward.

[0031] The left ends of the upper heating body 50, the central first heating body 51, the central second heating body 52, and the lower heating body 53 protrude more leftward than the left ends of the fins 54. The right ends of the upper heating body 50, the central first heating body 51, the central second heating body 52, and the lower heating body 53 protrude more rightward than the left ends of the fins 54.

[0032] Each fin 54 is a corrugated fin that has the shape of waves and is continuous and long laterally. The member forming the fin 54 is a thin sheet made of aluminium alloy, for example. The fins 54 are each arranged on upper and lower surfaces of the upper heating body 50, upper and lower surfaces of the central first heating body 51, upper and lower surfaces of the central second heating body 52, and upper and lower surfaces of the lower heating body 53. In other words, the fins 54 are stacked with the upper heating body 50, the central first heating body 51, the central second heating body 52, and the lower heating body 53. Because the fins 54 are in contact with the upper heating body 50, the central first heating body 51, the central second heating body 52, and the lower heating body 53, heats of the upper heating body 50, the central first heating body 51, the central second heating body 52, and the lower heating body 53 are efficiently transmitted to the fins 54. In an end portion of the electric heater in the stacking direction of the heating bodies 50 to 53 and the fins 54, that is, in a lower end portion thereof, a fin 54 is disposed.

[0033] As depicted in FIG. 3, for example, because the fins 54 are corrugated fins, on upper and lower portions of each fin 54, many crests 54a are formed so as to be laterally spaced apart from each other. A portion between each crest 54a of the upper portion of the fin 54 and the corresponding crest 54a of the lower portion thereof has a flat shape extending substantially in the vertical direction.

[0034] As depicted in FIG. 2, between two fins 54 and 54 arranged between the upper heating body 50 and the central first heating body 51, an upper insulating plate 56 extending laterally is arranged. These respective fins 54 are in contact with upper and lower surfaces of the upper insulating plate 56. Between two fins 54 and 54 arranged between the central first heating body 51 and the central second heating body 52, an intermediate insulating plate 57 extending laterally is arranged. These respective fins 54 are in contact with upper and lower surfaces of the intermediate insulating plate 57. Between two fins 54 and 54 arranged between the central second heating body 52 and the lower heating body 53, a lower insulating plate 58 extending laterally is arranged. These respective fins 54 are in contact with an upper surface and a lower surface of the lower insulating plate 58.

[0035] The upper insulating plate 56, the intermediate insulating plate 57, and the lower insulating plate 58 are members each formed of resin or other material having electrical insulating properties, for example, and configured to keep the vertically aligned fins 54 and 54 from being electrically connected to each other. The thickness (vertical dimension) of the upper insulating plate 56, the intermediate insulating plate 57, and the lower insulating plate 58 is set smaller than the thickness of the upper heating body 50, the central first heating body 51, the central second heating body 52, and the lower heating body 53. The left ends of the upper insulating plate 56, the intermediate insulating plate 57, and the lower insulating plate 58 protrude more leftward than the left ends of the fins 54. The left ends of the upper insulating plate 56, the intermediate insulating plate 57, and the lower insulating plate 58 protrude more rightward than the left ends of the fins 54.

[0036] The upper spring member 55 is arranged so as to be adjacent to the upper portion of the fin 54 positioned at the upper end of the electric heater 1, that is, on one side of the electric heater in the stacking direction of the heating bodies 50 to 53 and the fins 54. The upper spring member 55 is a component configured to apply biasing force so as to compress, in the stacking direction, the heating bodies 50 to 53, the insulating plate 56 to 58, and the fins 54 held by the holding frame 60, and the whole thereof is formed of a metal material the whole of which is elastic. As depicted in FIG. 4, for example, the upper spring member 55 has: a base-plate portion 55a extending laterally along the upper portion of the fin 54; an upstream elastically deformable portion 55b extending from a peripheral portion of the base-plate portion 55a on its upstream side in the flow direction of air to be air-conditioned; and a downstream elastically deformable portion 55c extending from a peripheral portion of the base-plate portion 55a on its downstream side in the flow direction of air to be air-conditioned.

[0037] The upstream elastically deformable portion 55b extends upward from the base-plate portion 55a and extends obliquely toward the downstream side in the flow direction of air to be air-conditioned, and then the tip portion thereof is bent to extend downward. The downstream elastically deformable portion 55c extends from the base-plate portion 55a and extends obliquely toward the upstream side in the flow direction of air to be air-conditioned, and then the tip portion thereof is bent to extend downward. The upstream elastically deformable portion 55b and the downstream elastically deformable portion 55c are configured to elastically deform downward.

[0038] As depicted in FIG. 5, the holding frame 60 is a component configured to accommodate and hold the upper heating body 50, the central first heating body 51, the central second heating body 52, the lower heating body 53, the fins 54, the upper spring member 55, the upper insulating plate 56, the intermediate insulating plate 57, and the lower insulating plate 58 in a stacked manner. Most part of a vertically intermediate portion of the holding frame 6 is open, and thus air to be air-conditioned blown into the holding frame 6 is heated when passing through the fins 54.

[0039] The holding frame 60 has an upstream frame-forming member (second frame-forming member) 70 disposed on the upstream side (one side) of the holding frame in the flow direction of air to be air-conditioned and a downstream frame-forming member (first frame-forming member) 80 disposed on the downstream side (the other side) thereof in the flow direction of air to be air-conditioned, and includes the upstream frame-forming member 70 and the downstream frame-forming member 80 in combination. The upstream frame-forming member 70 and the downstream frame-forming member 80 are each made by injection-molding resin material having electrical insulating properties. Herein, the flow direction of air to be air-conditioned may be a direction opposite to the direction depicted in FIG. 4. In this case, the frame-forming member 70 is disposed on the downstream side in the flow direction of air to be air-conditioned, and the frame-forming member 80 is disposed on the upstream side in the flow direction of air to be air-conditioned.

[0040] The downstream frame-forming member 80 has a downstream upper-peripheral portion 81 disposed on one side (upper side) of the downstream frame-forming member in the stacking direction of the heating bodies 50 to 53 and the fins 54, a downstream lower-peripheral portion 82 disposed on the other side (lower side) thereof in the stacking direction of the heating bodies 50 to 53 and the fins 54, and a downstream connecting portion 83. The downstream upper-peripheral portion 81 extends laterally. On a surface of the downstream upper-peripheral portion 81 on its upstream side in the flow direction of air to be air-conditioned, a plurality of upper holding walls (first holding walls) 81a protruding upstream and extending laterally are formed. The upper holding walls 81a are walls disposed in a manner laterally spaced apart from each other but may be a laterally continuous wall.

[0041] On the downstream lower-peripheral portion 82, a lower holding wall (second holding wall) 82a protruding upstream in the flow direction of air to be air-conditioned and extending laterally is formed. In the lower holding wall 82a, fitting holes 82b that are open to the upstream side in the flow direction of air to be air-conditioned and are laterally long are formed.

[0042] As depicted in FIG. 4, between the upper holding wall 81a and the lower holding wall 82a of the downstream frame-forming member 80, the heating bodies 50 to 53, the fins 54, the upper spring member 55, and the insulating plates 56 to 58 are disposed. The heating bodies 50 to 53, the fins 54, and the insulating plates 56 to 58 are stacked in the order described above. The upper spring member 55 is disposed between the fin 54 positioned uppermost and the downstream upper-peripheral portion 81. The distance between the upper holding wall 81a and the lower holding wall 82a of the downstream frame-forming member 80 is set equal to or larger than the total dimension, in the stacking direction, of the heating bodies 50 to 53, the fins 54, the insulating plates 56 to 58, and the upper spring member 55 that are stacked without external force in the stacking direction being applied thereto. The expression "without external force in the stacking direction being applied thereto" means that the upper spring member 55 is left free and kept from being elastically deformed, and also the heating bodies 50 to 53 and the fins 54 are kept from deforming.

[0043] Specifically, the distance between the upper holding wall 81a and the lower holding wall 82a is a distance between the lower surface (inner surface) 81b of the upper holding wall 81a and the upper surface (inner surface) 82c of the lower holding wall 82a. Than the dimension obtained through addition of all the dimensions of the dimension of the heating bodies 50 to 53 in the stacking direction (thickness direction), the dimension of the fins 54 in the stacking direction (height), the dimension of the upper spring member 55 in the stacking direction (thickness direction), and the dimension of the insulating plates 56 to 58 in the stacking direction (thickness direction), the distance between the lower surface 81b of the upper holding wall 81a and the upper surface 82c of the lower holding wall 82a is smaller by a dimension S.

[0044] The dimension S may be zero, and only needs to be such a dimension that allows compression force to be kept from acting on the heating bodies 50 to 53, the fins 54, the upper spring member 55, and the insulating plates 56 to 58 in a state in which these members are disposed between the upper holding wall 81a and the lower holding wall 82a. Because manufacturing tolerances are set for the heating bodies 50 to 53, the fins 54, the upper spring member 55, and the insulating plates 56 to 58, the dimension S is preferably set to several millimeters or larger, for example, in consideration of these tolerances. By this setting, even if all of the heating bodies 50 to 53, the fins 54, the upper spring member 55, and the insulating plates 56 to 58 have positive dimensions within the ranges of the respective tolerances, the compression force of the upper spring member 55 can be kept from acting in a state in which these members are disposed between the upper holding wall 81a and the lower holding wall 82a.

[0045] As depicted in FIG. 6 to FIG. 8, the upper surface 82c of the downstream lower-peripheral portion 82 of the downstream frame-forming member 80 serves as a contact surface with which a lower portion of the fin 54 disposed in the lower end portion of the electric heater is brought into contact. On the upper surface 82c of the downstream lower-peripheral portion 82, a plurality of projections 82e that are each disposed between adjacent crests 54a and 54a of the fin 54 are formed in a manner laterally spaced apart from each other at an interval corresponding to the distance between the crests 54a and 54a. Each projection 82e is a frame engagement portion configured to laterally engage with the crests 54a and 54a of the fin 54. The projection 82e laterally engages with the crests 54a and 54a of the fin 54, whereby the crests 54a can be kept from being laterally displaced when the fin 54 is compressed. Each frame engagement portion may be formed of a protrusion, for example.

[0046] The downstream connecting portion 83 is a portion having a rod-like shape extending from the upper holding wall 81a to the lower holding wall 82a and connecting between the upper holding wall 81a and the lower holding wall 82a while the above-described distance is being maintained. The downstream connecting portion 83 is positioned on the downstream side in the flow direction of air to be air-conditioned, and holds the heating bodies 50 to 53, the fins 54, the upper spring member 55, and the insulating plates 56 to 58 from the downstream side in the flow direction of air to be air-conditioned. The downstream connecting portion 83 is provided in plurality in a manner laterally spaced apart from each other so that air to be air-conditioned can flow through between the downstream connecting portions 83. Each downstream connecting portion 83 may be a vertically extending member, or may be an obliquely extending member.

[0047] As depicted in FIG. 9, on the lower surface of the lower insulating plate 58, a plurality of projections 58a protruding downward from the insulating plate 58 and each disposed between adjacent crests 54a and 54a of the fin 54 disposed on the lower side of the insulating plate 58 are formed in a manner laterally spaced apart from each other at an interval corresponding to the distance between the crests 54a and 54a. Each projection 58a of the insulating plate 58 is a plate engagement portion configured to laterally engage with the crests 54a and 54a of the fin 54. The projection 58a of the insulating plate 58 laterally engages with the crests 54a and 54a of the fin 54, whereby the crests 54a can be kept from being laterally displaced when the fin 54 is compressed.

[0048] As depicted in FIG. 6, on the upper surface of the lower insulating plate 58, a plurality of projections 58b protruding upward from the insulating plate 58 and each disposed between adjacent crests 54a and 54a of the fin 54 disposed on the upper side of the insulating plate 58 are formed in a manner laterally spaced apart from each other at an interval corresponding to the distance between the crests 54a and 54a. Each projection 58b of the insulating plate 58 is a plate engagement portion configured to laterally engage with the crests 54a and 54a of the fin 54. The projection 58b of the insulating plate 58 laterally engages with the crests 54a and 54a of the fin 54, whereby the crests 54a can be kept from being laterally displaced when the fin 54 is compressed. Each plate engagement portion may be formed of a protrusion, for example.

[0049] Herein, also on the upper insulating plate 56 and the intermediate insulating plate 57, plate engagement portions having the same structure as described above may be formed.

[0050] The upstream frame-forming member 70 has an upstream upper-peripheral portion (first coupling portion) 71 disposed on one side (upper side) of the upstream frame-forming member in the stacking direction of the heating bodies 50 to 53 and the fins 54, an upstream lower-peripheral portion (second coupling portion) 72 disposed on the other side (lower side) thereof in the stacking direction of the heating bodies 50 to 53 and the fins 54, a left connecting portion (other-side connecting portion) 73, a right connecting portion (other-side connecting portion) 74, intermediate connecting portions (other-side connecting portions) 75, and a spring compression portion (one-side spring compression portion) 76. The upstream upper-peripheral portion 71 extends laterally. In the upstream upper-peripheral portion 71, fitting holes 71a that are open to the downstream side in the flow direction of air to be air-conditioned and are laterally long are formed so as to correspond to the upper holding walls 81a of the downstream frame-forming member 80. Into the fitting holes 71a, the upper holding walls 81a of the downstream frame-forming member 80 are inserted to be fitted, whereby the upstream upper-peripheral portion 71 is coupled to the upper holding wall 81a.

[0051] On a surface of the upstream lower-peripheral portion 72 on its downstream side in the flow direction of air to be air-conditioned, coupling-plate portions 72a protruding downstream and extending laterally are formed so as to correspond to the fitting holes 82b of the downstream frame-forming member 80. The coupling-plate portions 72a are inserted to be fitted into the fitting holes 82b of the downstream frame-forming member 80, whereby the upstream lower-peripheral portion 72 is coupled to the lower holding wall 82a.

[0052] The spring compression portion 76 is positioned on the lower side of the upstream upper-peripheral portion 71 and, as a whole, has a plate-like shape extending laterally. The spring compression portion 76 is a component configured to be inserted into a space between the upper holding walls 81a of the downstream frame-forming member 80 and the upper spring member 55 to elastically deform the upper spring member 55 in the stacking direction of the heating bodies 50 to 53 and the fins 54. The vertical dimension that is a thickness dimension of the spring compression portion 76 is set larger than the dimension S, and is a dimension that enables the upper spring member 55 to be elastically deformed as depicted in FIG. 5 by 1 millimeter or more, for example. Herein, the compression force of the upper spring member 55 can be adjusted depending on the thickness dimension of the spring compression portion 76. Specifically, the compression force of the upper spring member 55 is preferably set to the extent that the heating bodies 50 to 53 and the fins 54, for example, are not displaced.

[0053] A portion of the spring compression portion 76 on its downstream side in the flow direction of air to be air-conditioned is a tip portion toward the insertion direction into the above-described space, and thus the thickness of this tip portion of the spring compression portion 76 is set to be smaller at a position closer to the tip. By this setting, the tip portion of the spring compression portion 76 can be easily inserted into the space.

[0054] As depicted in FIG. 3, a surface of the spring compression portion 76 closer to the upper spring member 55, that is, a lower surface 76a of the spring compression portion 76 extends laterally. On the lower surface 76a of the spring compression portion 76, a plurality of projections 76b extending in the insertion direction into the space are formed so as to be laterally spaced apart from each other. The projections 76b are continuous on the lower surface 76a of the spring compression portion 76 from the upstream end to the downstream end thereof in the flow direction of air to be air-conditioned. The projections 76b are formed so as to be brought into contact with the upstream elastically deformable portion 55b and the downstream elastically deformable portion 55c of the upper spring member 55. By forming these projections, the sliding area between the spring compression portion 76 and the upper spring member 55 when the spring compression portion is inserted into the above-described space can be reduced, whereby the sliding resistance therebetween can be reduced. Herein, the number of the projections 76b is not limited to a particular number.

[0055] As depicted in FIG. 1 and FIG. 2, the left connecting portion 73 has a rod-like shape extending from a left portion of the upstream upper-peripheral portion 71 to a left portion of the upstream lower-peripheral portion 72. The right connecting portion 74 has a rod-like shape extending from a right portion of the upstream upper-peripheral portion 71 to a right portion of the upstream lower-peripheral portion 72. Each intermediate connecting portion 75 has a rod-like shape extending from a laterally intermediate portion of the upstream upper-peripheral portion 71 to a laterally intermediate portion of the upstream lower-peripheral portion 72.

[0056] The left connecting portion 73, the right connecting portion 74, and the intermediate connecting portions 75 are portions connecting between the upstream upper-peripheral portion 71 and the upstream lower-peripheral portion 72 while keeping a predetermined distance therebetween. Furthermore, the left connecting portion 73, the right connecting portion 74, and the intermediate connecting portions 75 are positioned on the upstream side in the flow direction of air to be air-conditioned, and holds the heating bodies 50 to 53, the fins 54, the upper spring member 55, and the insulating plates 56 to 58 from the upstream side in the flow direction of air to be air-conditioned. Among the left connecting portion 73, the right connecting portion 74, and the intermediate connecting portions 75, air to be air-conditioned flows through. Herein, the left connecting portion 73, the right connecting portion 74, and the intermediate connecting portions 75 may be portions extending vertically, or may be portions extending obliquely.

[0057] As depicted in FIG. 1, on the left end and the right end of the electric heater 1, a left cap member 91 and a right cap member 92 are provided, respectively. The left cap member 91 is formed so as to cover the left ends of the upstream frame-forming member 70 and the downstream frame-forming member 80, and is formed to be fitted onto these left ends. The right cap member 92 is formed so as to cover the right ends of the upstream frame-forming member 70 and the downstream frame-forming member 80, and is formed to be fitted onto these right ends.

(Method for Manufacturing Electric Heater)

[0058] The following describes a procedure of assembling the electric heater 1 configured as described above. To begin with, as depicted in FIG. 4, the upper heating body 50, the central first heating body 51, the central second heating body 52, the lower heating body 53, fins 54, the upper insulating plate 56, the intermediate insulating plate 57, and the lower insulating plate 58 are stacked, and are accommodated in the downstream frame-forming member 80. Specifically, the heating bodies 50 to 53, the fins 54, and the insulating plates 56 to 58 are stacked in the order described above, and are disposed between the upper holding walls 81a and the lower holding wall 82a of the downstream frame-forming member 80. The upper spring member 55 is then disposed between the fin 54 positioned uppermost and the downstream upper-peripheral portion 81.

[0059] At this time, the distance between the upper holding walls 81a and the lower holding wall 82a of the downstream frame-forming member 80 is kept equal to or larger than the total dimension, in the stacking direction, of the heating bodies 50 to 53, the fins 54, the insulating plates 56 to 58, and the upper spring member 55, and thus compression force of the upper spring member 55 does not act on the heating bodies 50 to 53 and the fins 54. Consequently, even before the upstream frame-forming member 70 is assembled to the downstream frame-forming member 80, the heating bodies 50 to 53 and the fins 54 are less likely to be ejected from the downstream frame-forming member 80, and thus assembling workability is improved.

[0060] Furthermore, during assembly of the upstream frame-forming member 70 to the downstream frame-forming member 80, when the spring compression portion 76 is inserted between the upper holding walls 81a and the upper spring member 55, the compression force of the upper spring member 55 does not act. Thus, force required at the start of the assembly does not have to be great, which also improves the assembling workability.

[0061] When the spring compression portion 76 is inserted between the upper holding walls 81a and the upper spring member 55, the upper spring member 55 is elastically deformed in the stacking direction of the heating bodies 50 to 53 and the fins 54, whereby the heating bodies 50 to 53, the fins 54, and the insulating plates 56 to 58 are compressed in the stacking direction. Thus, backlash between the heating bodies 50 to 53, the fins 54, and the insulating plates 56 to 58 is substantially eliminated.

[0062] When the upstream frame-forming member 70 is assembled to the downstream frame-forming member 80, the upper holding walls 81a of the downstream frame-forming member 80 are inserted to be fitted into the fitting holes 71a of the upstream frame-forming member 70, whereby the upstream upper-peripheral portion 71 is coupled to the upper holding wall 81a. The coupling-plate portions 72a of the upstream frame-forming member 70 on its lower side are inserted to be fitted into the fitting holes 82b of the downstream frame-forming member 80, whereby the upstream lower-peripheral portion 72 is coupled to the lower holding wall 82a. By this assembling, the heating bodies 50 to 53, the fins 54, the insulating plates 56 to 58, and the upper spring member 55 are held by the left connecting portion 73, the right connecting portion 74, the intermediate connecting portions 75, and the downstream connecting portions 83 from both sides in the flow direction of air to be air-conditioned. Finally, the left cap member 91 and the right cap member 92 are assembled to the holding frame 60.

(Effects of Embodiment)

[0063] As described in the foregoing, according to the present embodiment, the projections 82e of the downstream lower-peripheral portion 82 of the downstream frame-forming member 80 engage with the crests 54a of the fin 54 disposed in the lower end portion of the electric heater, and thus the crests 54a of the fin 54 are less likely to be displaced. In other words, without soldering a plate member to the fin 54, the fin pitch is less likely to deviate from the design value, and thus the airflow resistance can be kept appropriate and the heating performance of the electric heater 1 can be increased.

[0064] On the insulating plates 56 to 58 each disposed between the fins 54 and 54, the projections 58a and 58b each configured to engage with crests 54a of the corresponding fin 54 are formed, and thus the pitch of the fins positioned in an intermediate portion of the electric heater in the stacking direction can be kept from deviating.

[0065] Before assembling the upstream frame-forming member 70 and the downstream frame-forming member 80 that constitute the holding frame 60, the upper spring member 55 assembled to the downstream frame-forming member 80 can be kept from applying force in the stacking direction to the heating bodies 50 to 53, the fins 54, and the insulating plates 56 to 58. Thus, the heating bodies 50 to 53, the fins 54, and the insulating plates 56 to 58 are less likely to be ejected from the downstream frame-forming member 80, and force required at the start of the assembly does not have to be great. Consequently, assembling workability can be improved.

[0066] The distance between the upper holding walls 81a and the lower holding wall 82a of the downstream frame-forming member 80 is set larger than the total dimension, in the stacking direction, of the heating bodies 50 to 53, the fins 54, the insulating plates 56 to 58, and the upper spring member 55. Thus, even if a slight dimensional error in the stacking direction has occurred in the heating bodies 50 to 53 or the fins 54, for example, the assembling workability can be improved.

[0067] On the spring compression portion 76 of the upstream frame-forming member 70, the projections 76b extending in the insertion direction are formed. Thus, when the spring compression portion 76 is inserted between the upper holding walls 81a and the upper spring member 55, sliding resistance between the spring compression portion 76 and the upper spring member 55 can be reduced. Consequently, the assembling workability can be further improved.

[0068] The above-described embodiments are merely examples in every respect, and the present invention should not be construed as limited to these embodiments. Furthermore, modifications and changes belonging to the scope equivalent to the claims are all within the scope of the present invention.

INDUSTRIAL APPLICABILITY

[0069] As described in the foregoing, the present invention can be applied to an air conditioner installed in an automobile, for example.

DESCRIPTION OF REFERENCE CHARACTERS

[0070]

1	Electric Heater
50 to 53	Heating Body
54	Fin
55	Upper Spring Member
56 to 58	Insulating Plate
58a, 58b	Projection (Plate Engagement Portion)
60	Holding Frame
82c	Upper Surface (Contact Surface) of Downstream Lower-Peripheral Portion
82e	Projection (Frame Engagement Portion)

Claims

1. An electric heater of an air conditioner for a vehicle, the electric heater comprising:

 a heating body configured to generate heat when being supplied with electric power;
 corrugated fins arranged in a manner stacked on the heating body;
 a spring member configured to apply compression force to the heating body and the fins in a stacking direction; and
 a holding frame configured to accommodate and hold the heating body, the fins, and the spring member in a stacked manner,
 wherein
 air to be air-conditioned blown into the holding frame is heated when passing through the fins,
 a fin of the fins is disposed so as to be positioned in an end portion of the electric heater in the stacking direction, and
 on the holding frame, a frame engagement portion configured to engage with crests of the fin disposed in the end portion in the stacking direction is formed.

2. The electric heater of claim 1, wherein
 the holding frame has a contact surface with which the fin disposed in the end portion in the stacking

direction is brought into contact, and
the frame engagement portion is a projection protruding from the contact surface and disposed between adjacent crests of the fin.

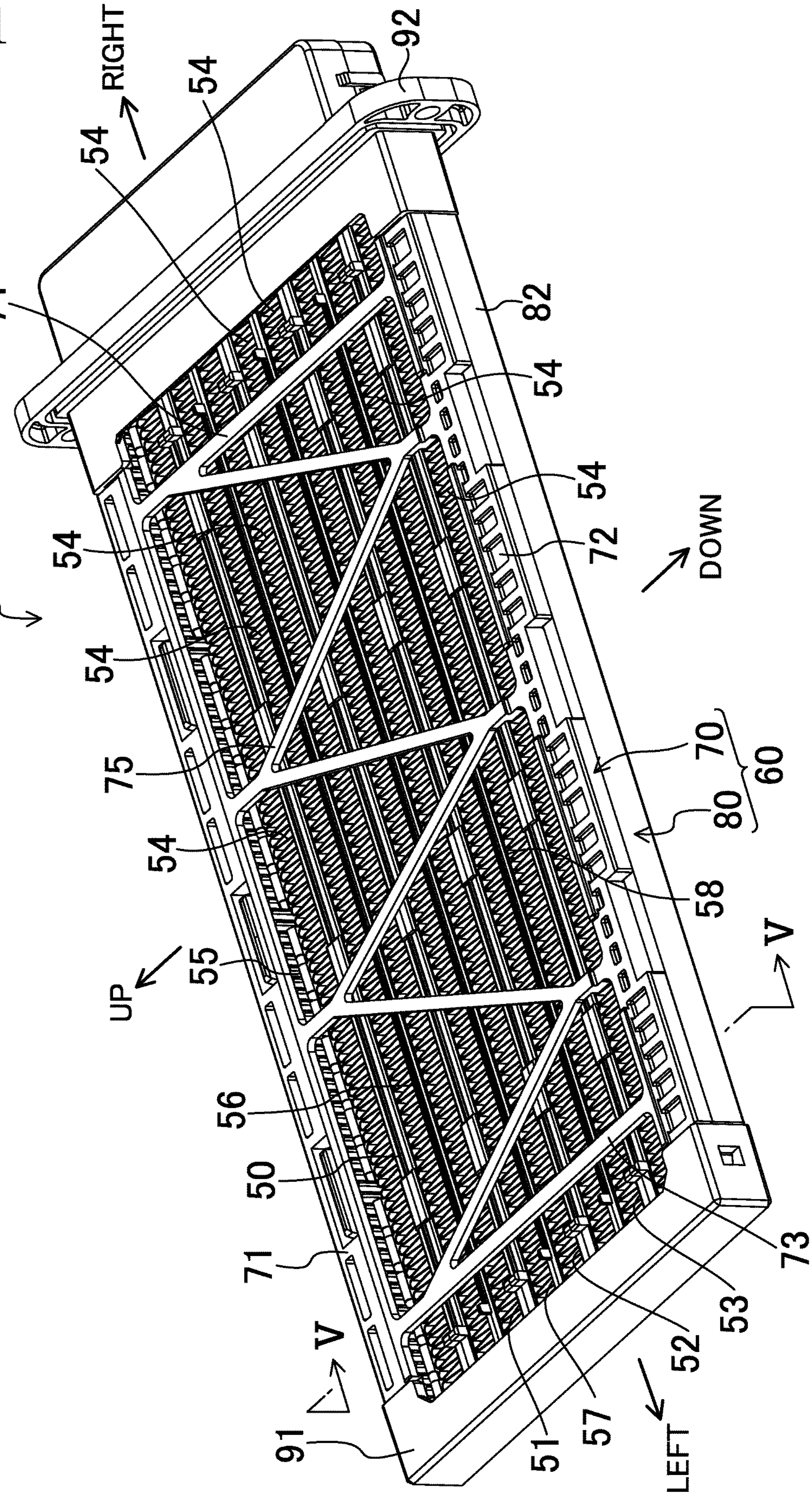
3. The electric heater of claim 2, wherein,
an insulating plate is interposed between the fins stacked in the stacking direction, and
a plate engagement portion configured to engage with crests of each fin is formed on the insulating plate.

4. The electric heater of claim 3, wherein,
the plate engagement portion is a projection protruding from the insulating plate and disposed between adjacent crests of each fin.

5. An electric heater of an air conditioner for a vehicle, the electric heater comprising:

a heating body configured to generate heat when being supplied with electric power;
corrugated fins arranged in a manner stacked on the heating body;
a spring member configured to apply compression force to the heating body and the fins in a stacking direction;
an insulating plate interposed between the fins stacked in the stacking direction; and
a holding frame configured to accommodate and hold the heating body, the fins, the spring member, and the insulating plate in a stacked manner,
wherein
air to be air-conditioned blown into the holding frame is heated when passing through the fins, and
on the insulating plate, a plate engagement portion configured to engage with crests of each fin is formed.

FIG. 1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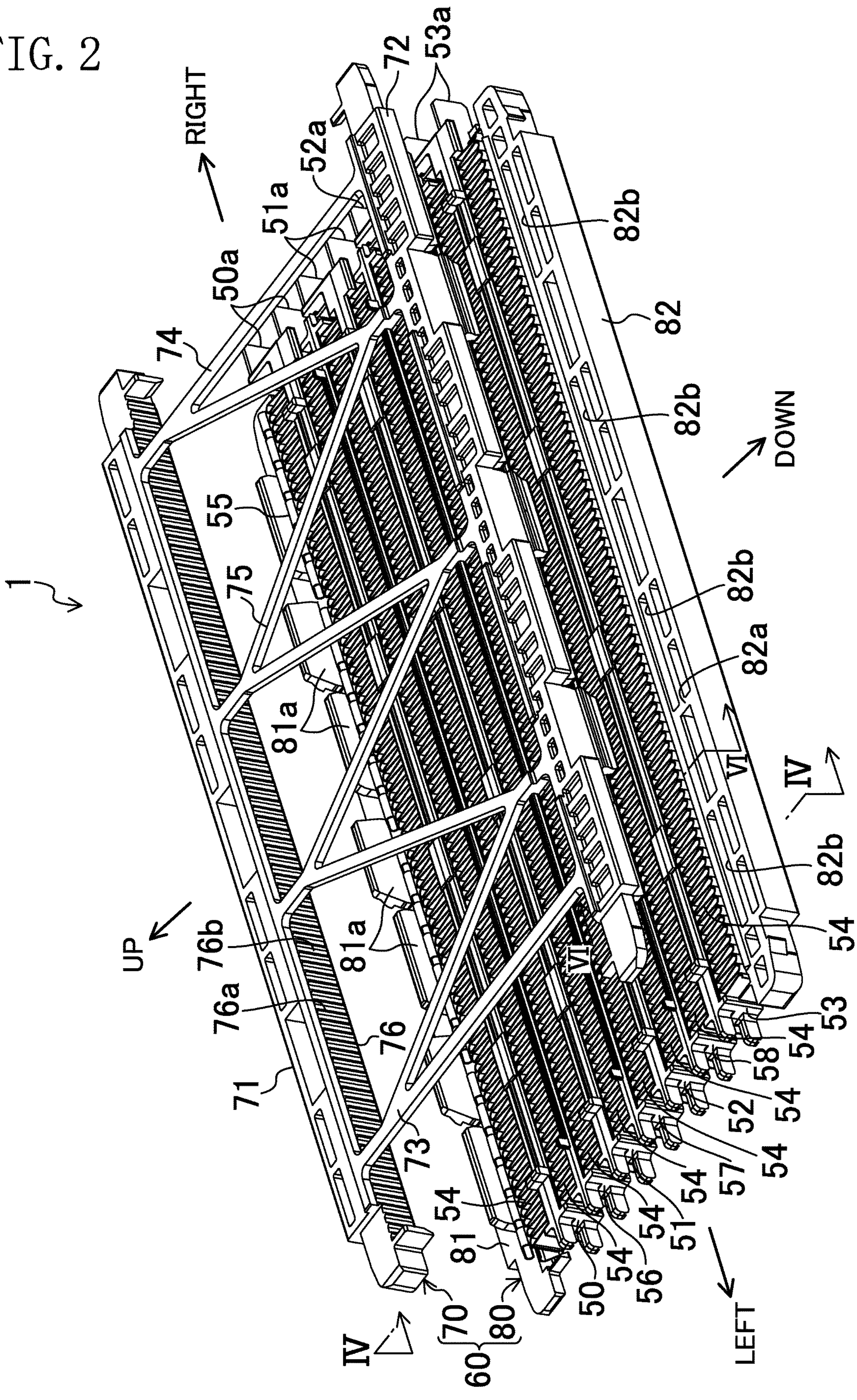
74
75
80
82
91
92

FIG. 2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76
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73
54
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58
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FIG. 3

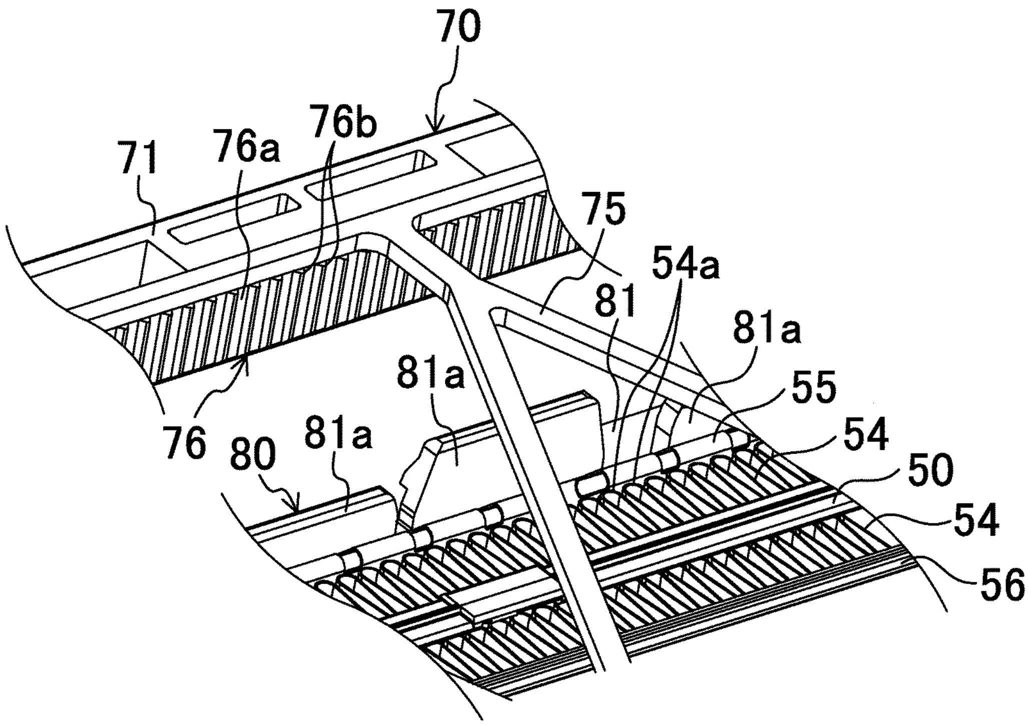
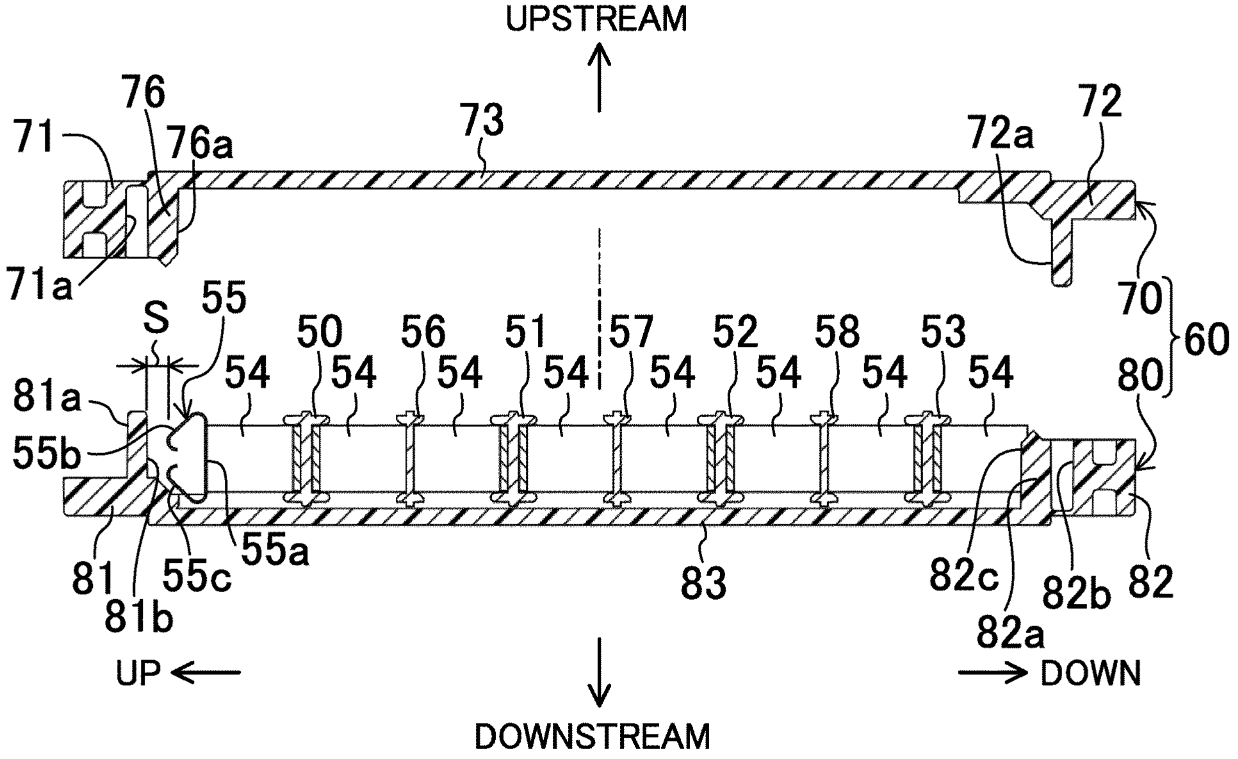


FIG. 4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54
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81b
55c
55a
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82c
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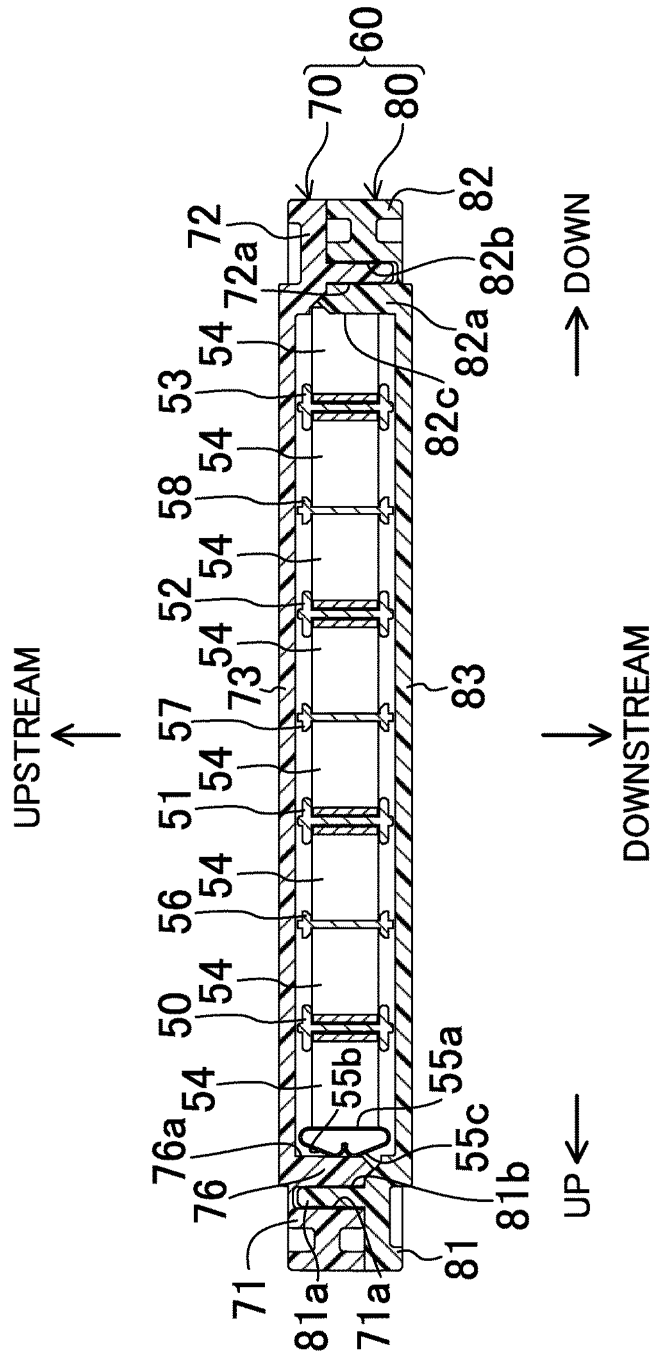
82b
82
UP
DOWN
DOWNSTREAM

FIG. 5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DOWNSTREAM
55b
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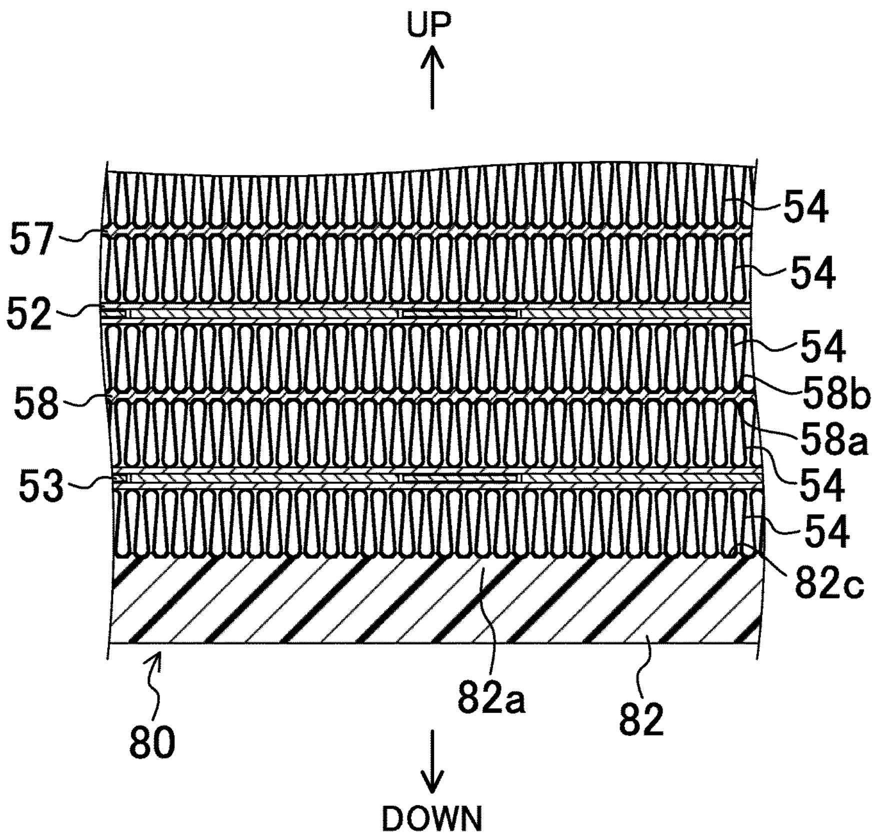
55c
76a
76
81b
UP
71
81a
71a
81

FIG. 6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57
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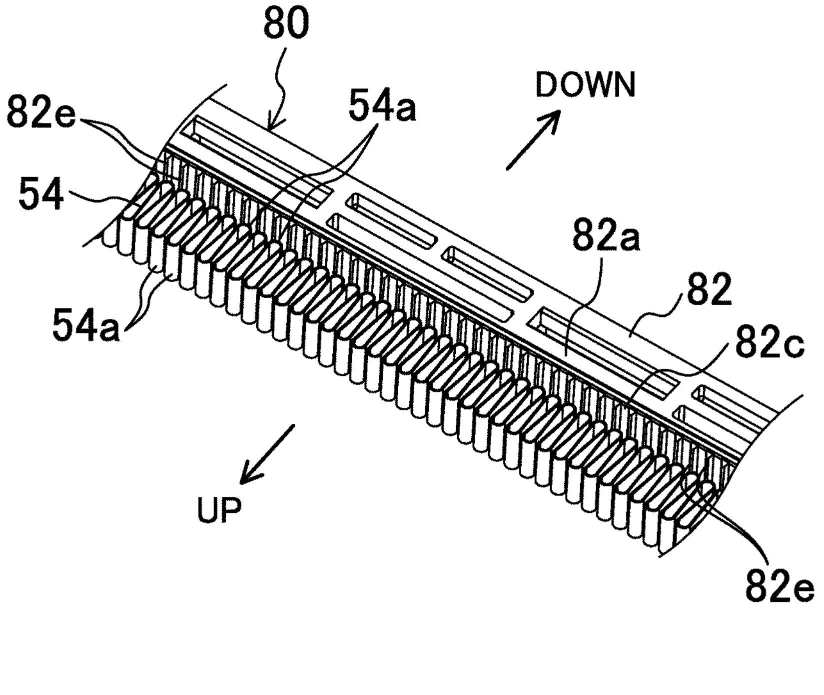
52
54
58b
58
58a
54
53
54
82c
80
82a
82
DOWN

FIG. 7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82e
54a
54
82a
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82c
54a
UP
82e

FIG. 8

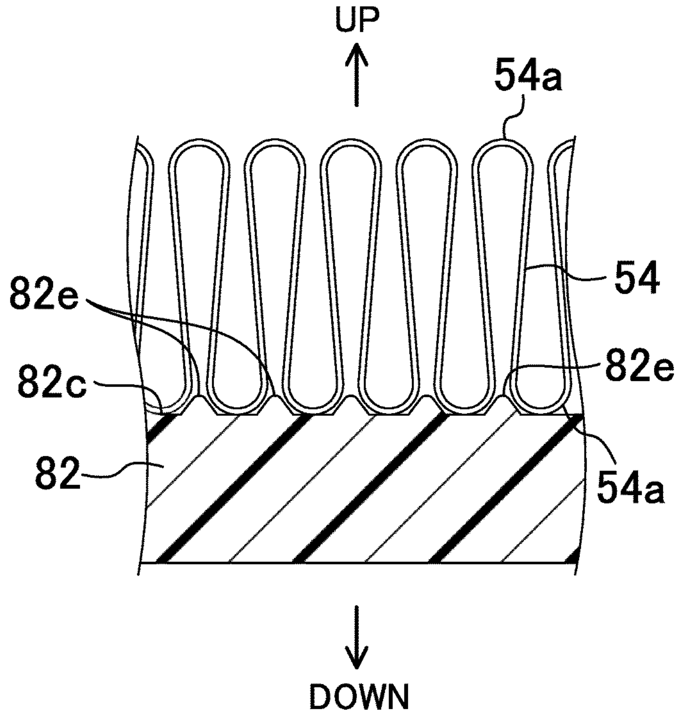
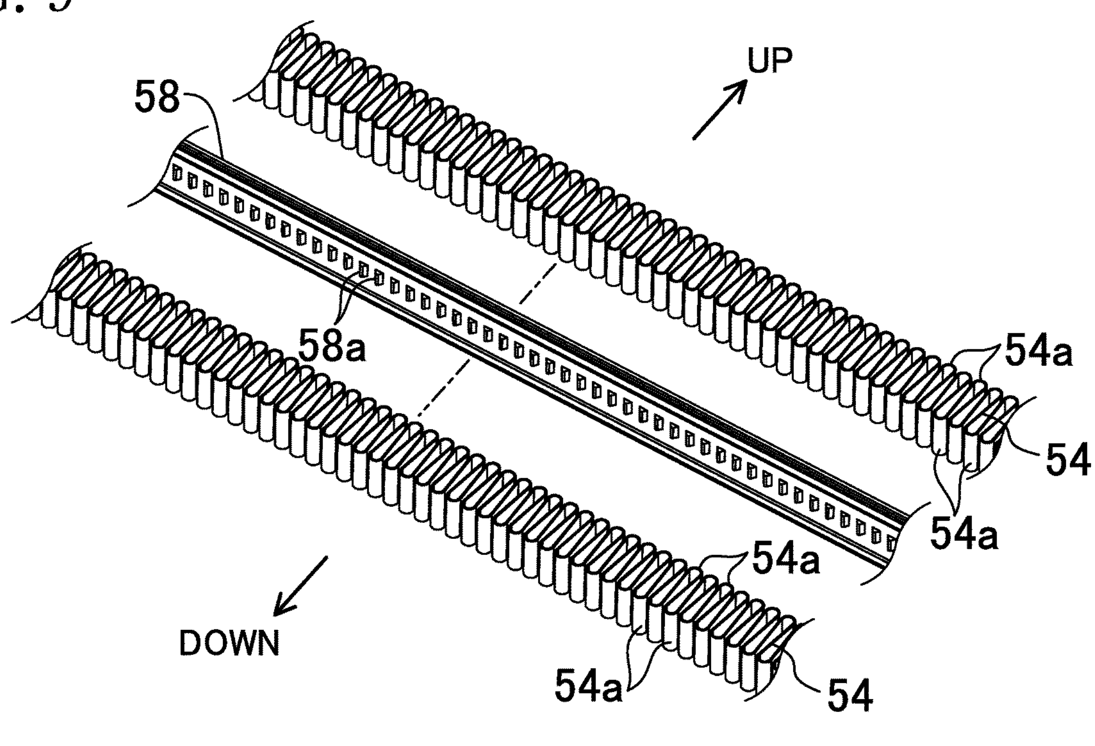

UP
54a
54
82e
82e
82c
82
54a
DOWN

FIG. 9


UP
58
58a
54a
54
54a
54a
DOWN
54a
54

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/041146

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. B60H1/22(2006.01)i, B60H1/03(2006.01)i, F24H3/04(2006.01)i, H05B3/06(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. B60H1/00-3/06, F24H3/00-3/04, H05B3/02-3/18, 3/40-3/82, F24H9/18, F28F3/00-3/14

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2016-107865 A (JAPAN CLIMATE SYSTEMS CORPORATION) 20 June 2016, paragraphs [0021]-[0043], fig. 2-4 & WO 2016/092726 A1	1-5
Y	JP 8-204074 A (CALSONIC CORP.) 09 August 1996, paragraphs [0030]-[0049], fig. 1-4 (Family: none)	1-5
Y	JP 2010-132080 A (DENSO CORP.) 17 June 2010, paragraphs [0055]-[0056], fig. 3 (Family: none)	3-5
A	JP 61-33251 Y2 (NISSAN DIESEL ENGINEERING CO., LTD.) 29 September 1986, column 1, line 21 to column 2, line 5, fig. 2 (Family: none)	1-5

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"P" document published prior to the international filing date but later than the priority date claimed
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05 February 2018 (05.02.2018)	13 February 2018 (13.02.2018)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	 Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/041146

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1839920 A1 (BEGR GMBH. & CO. KG.) 13 October 2007, paragraphs [0049]-[0050], fig. 20-28 (Family: none)	1-5
A	JP 2005-147502 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 09 June 2005, paragraphs [0019], [0029], [0037], fig. 3, 8 (Family: none)	1-5

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 4880648 B **[0005]**
- JP 4939490 B **[0005]**