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(54) ELECTRICAL HEATER, HEATING HEAT EXCHANGER AND VEHICLE AIR CONDITIONER

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(57) **ABSTRACT**

An electrical heater includes plural heating body plates arranged in parallel with each other to define an air passage between adjacent two thereof, a positive electrode member joined to one end side of each heating body plate, and a negative electrode member joined to the other end side of each heating body plate. In the electrical heater, the heating body plates are arranged to directly heat air passing through the air passage when electrical power is supplied to the heating body plates through the electrode members. Accordingly, the electrical heater can effectively heat air with a simple structure.

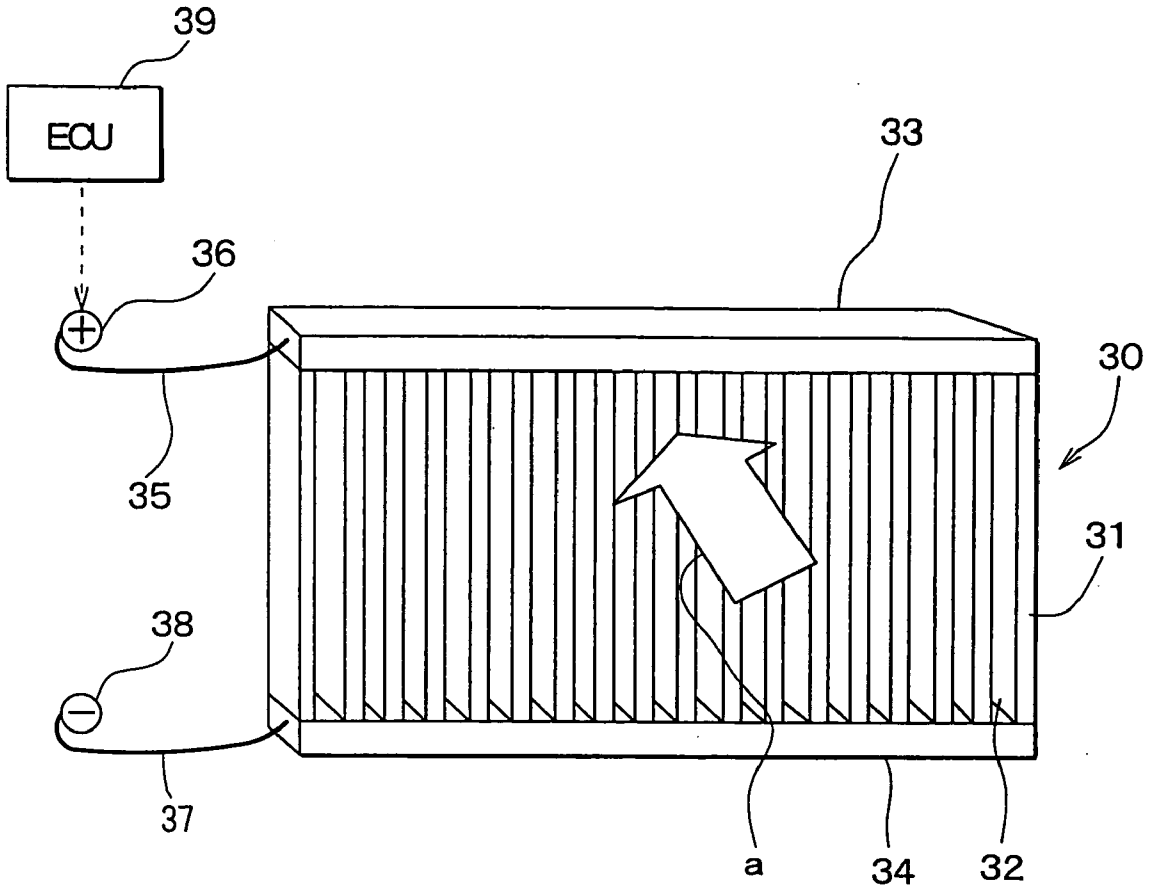

FIG. 1

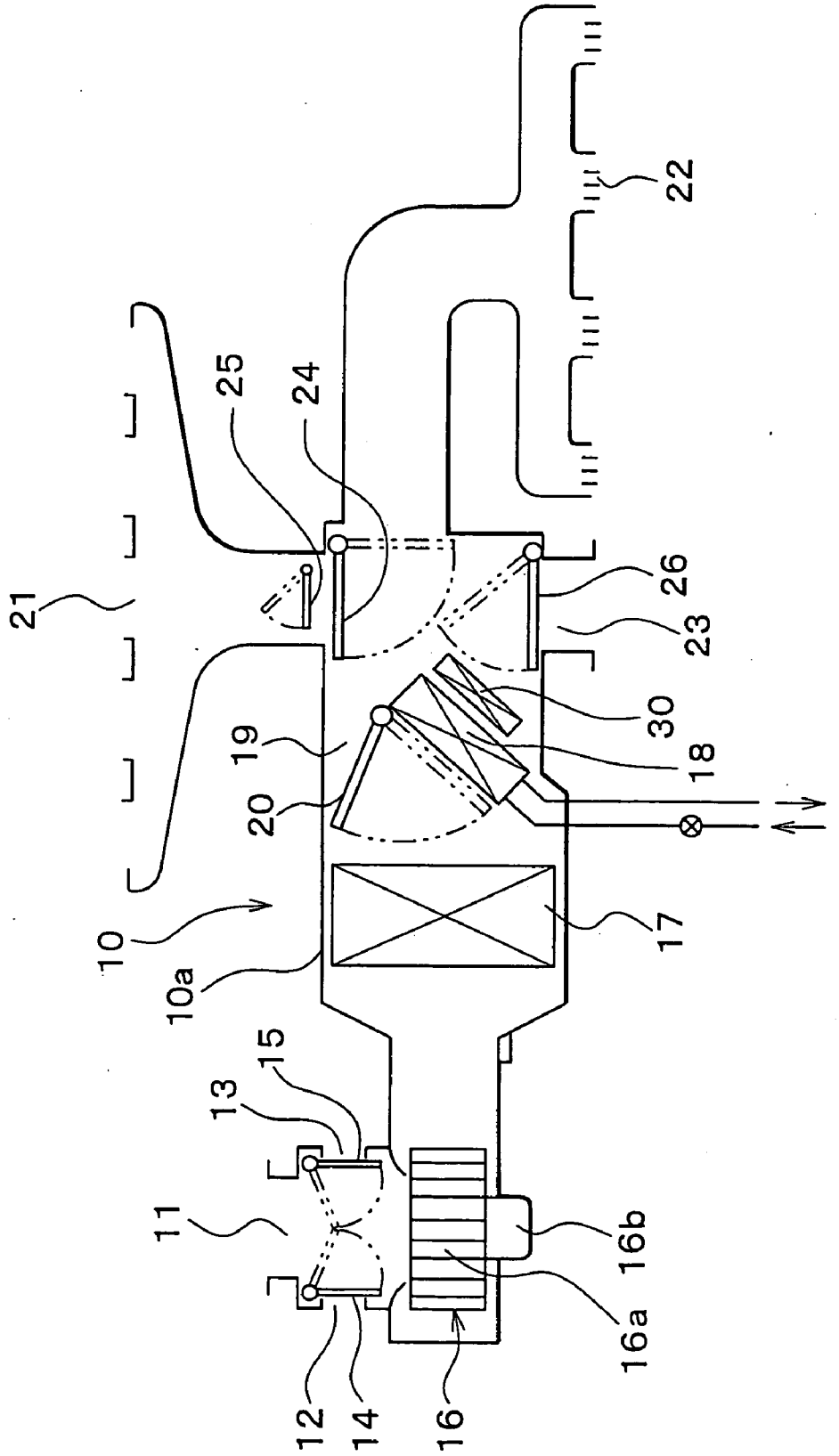

FIG. 2

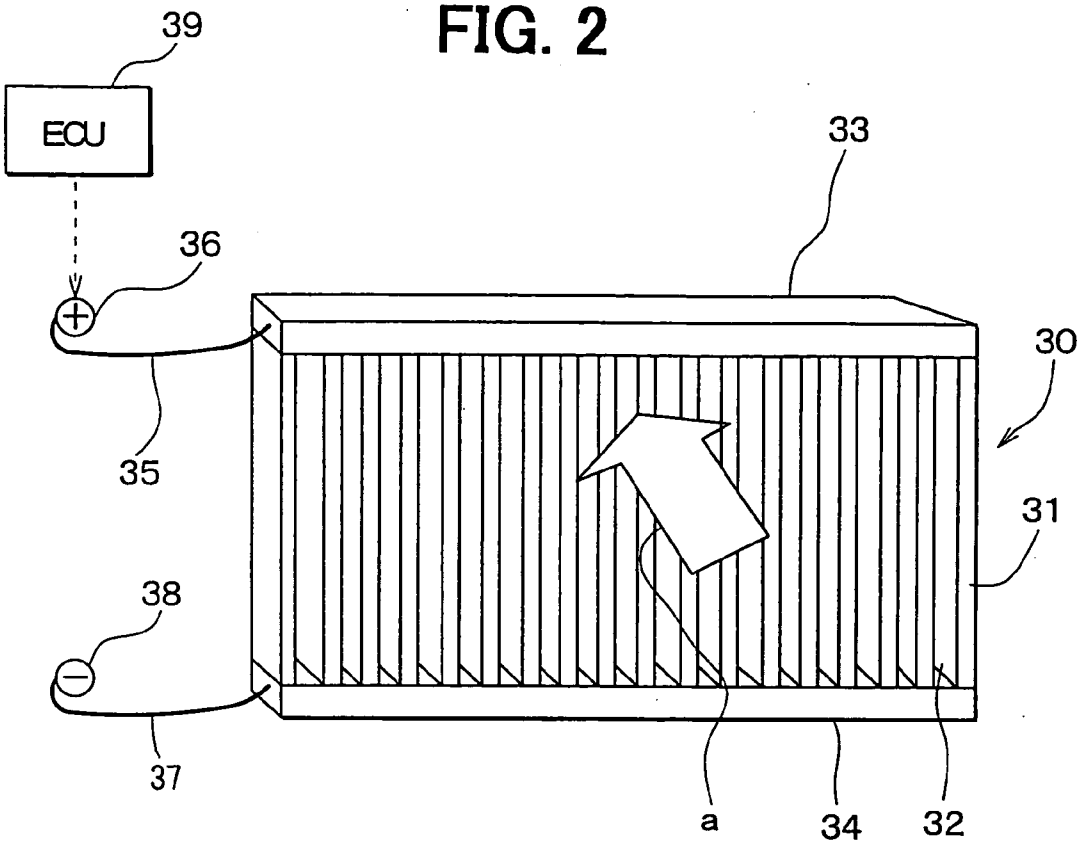
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FIG. 3

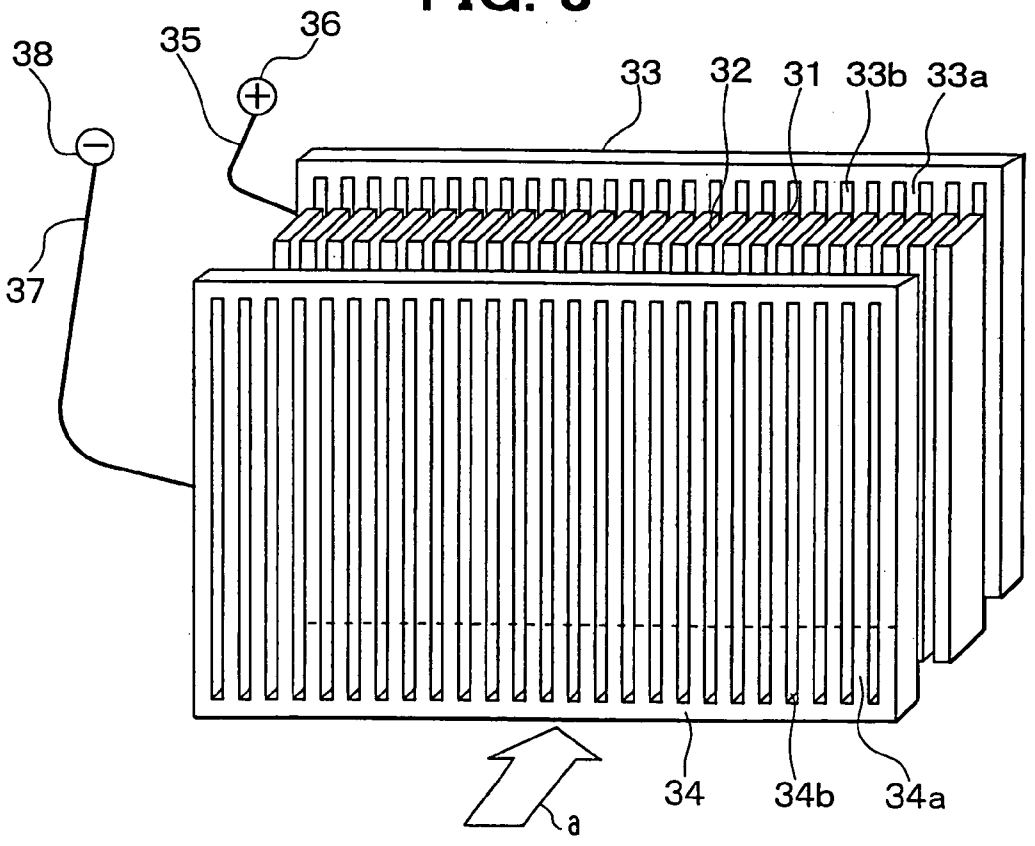
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FIG. 4A

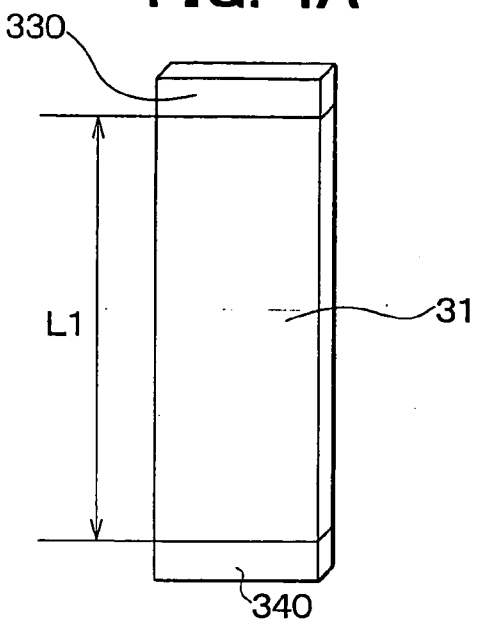

FIG. 4B

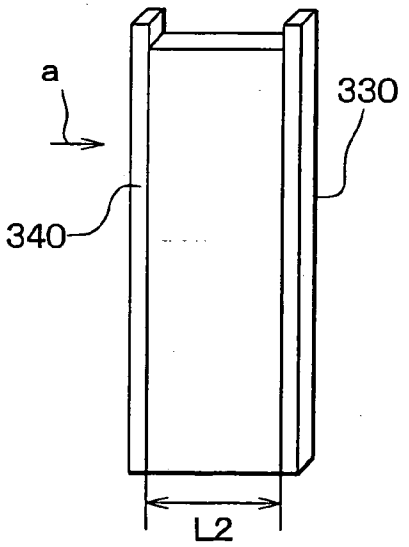

FIG. 5A

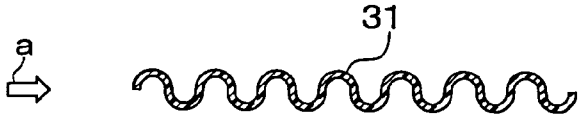

FIG. 5B

FIG. 5C

FIG. 5D

FIG. 5E

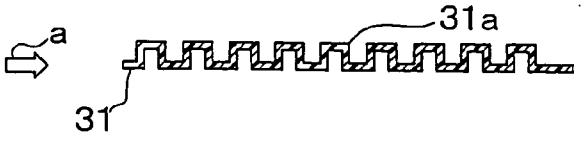

FIG. 6A

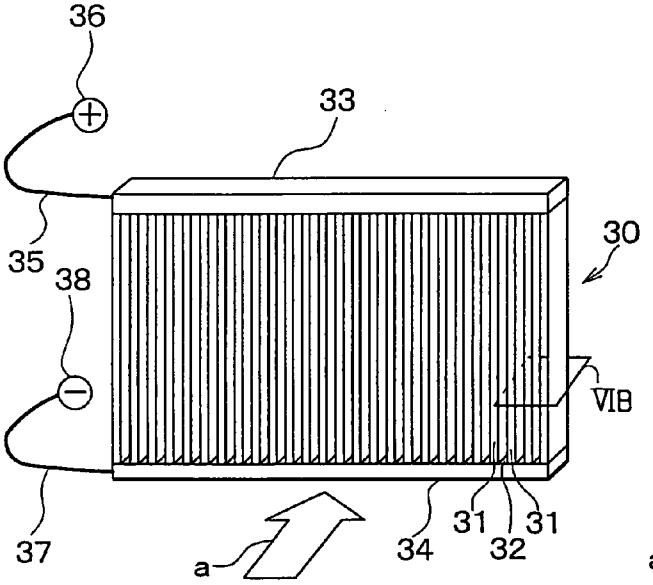

FIG. 6B

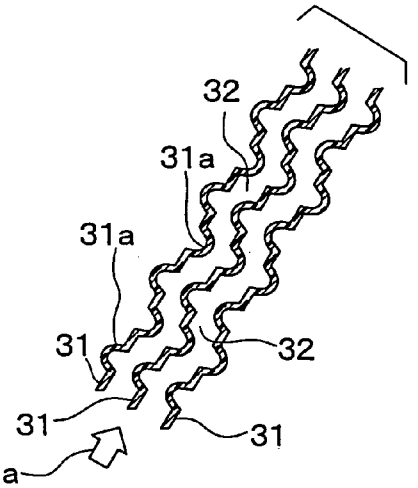

FIG. 7A

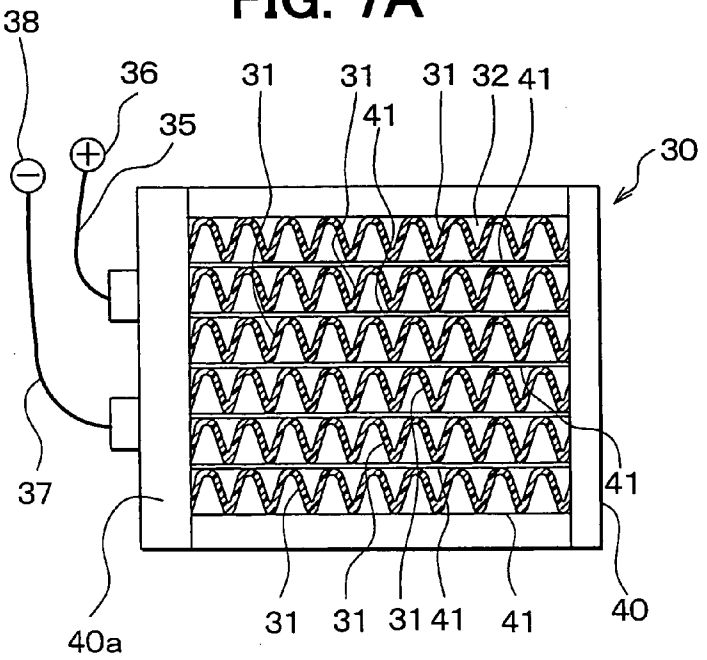

FIG. 7B

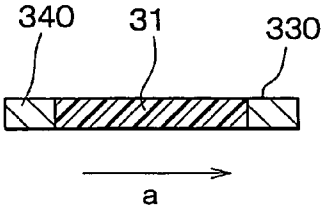

FIG. 8

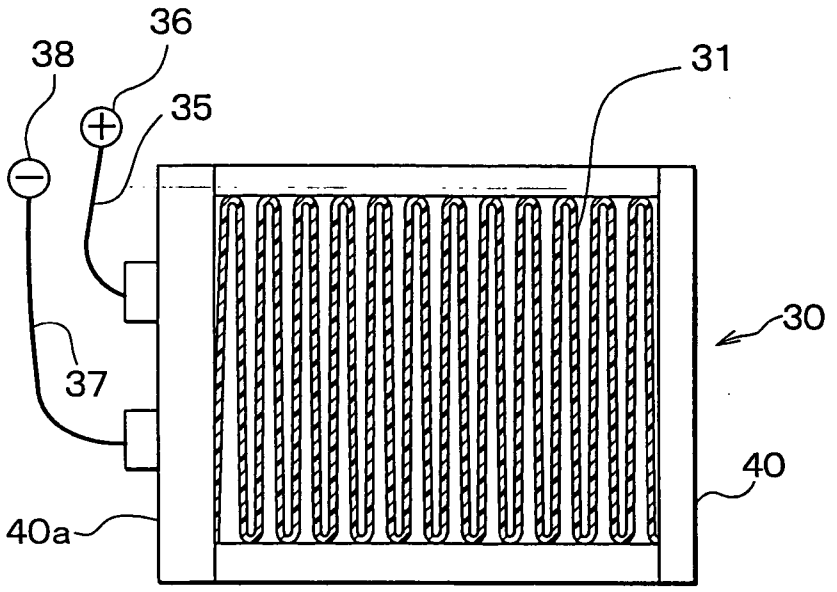

FIG. 9

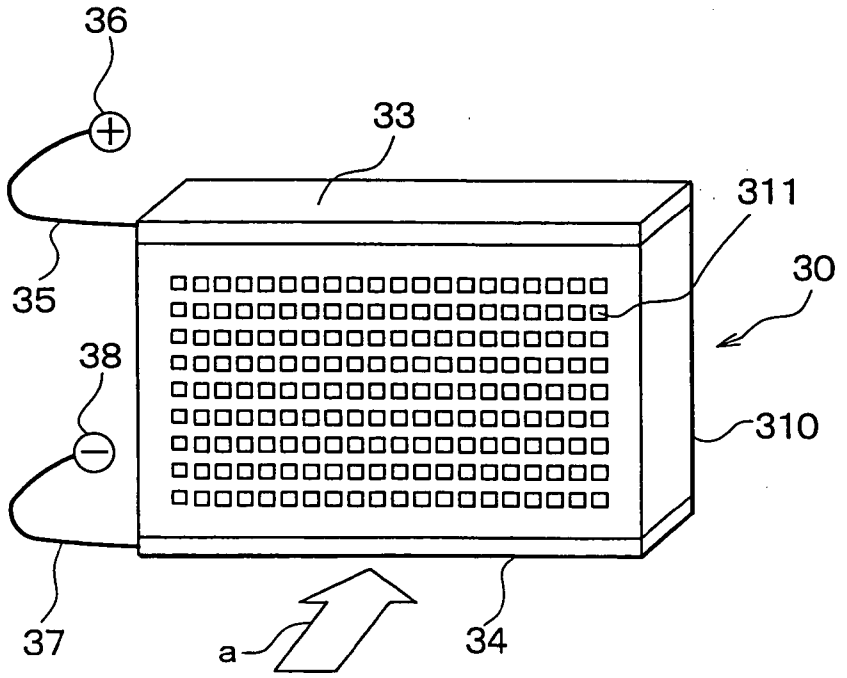

FIG. 10

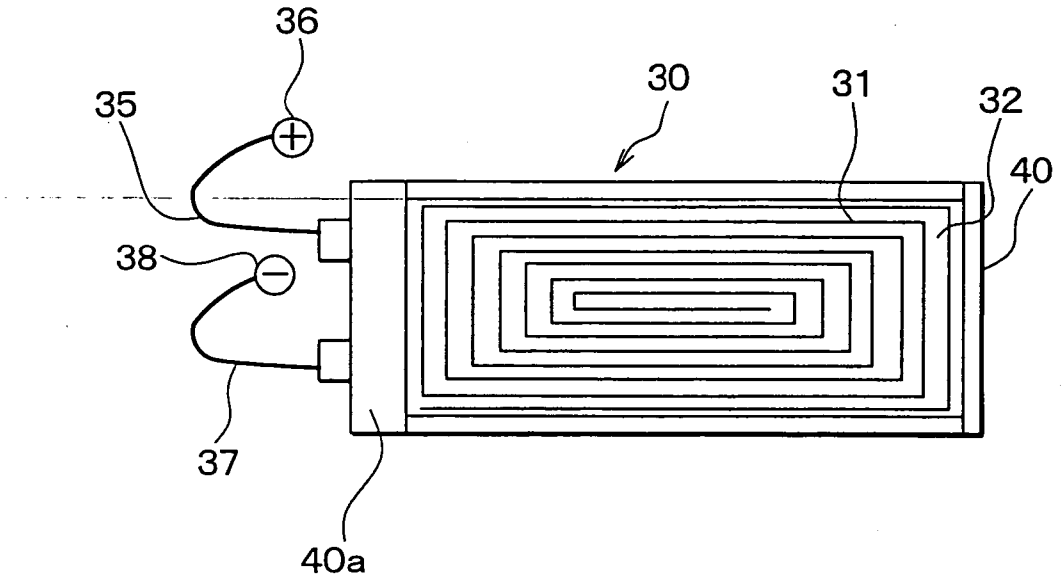
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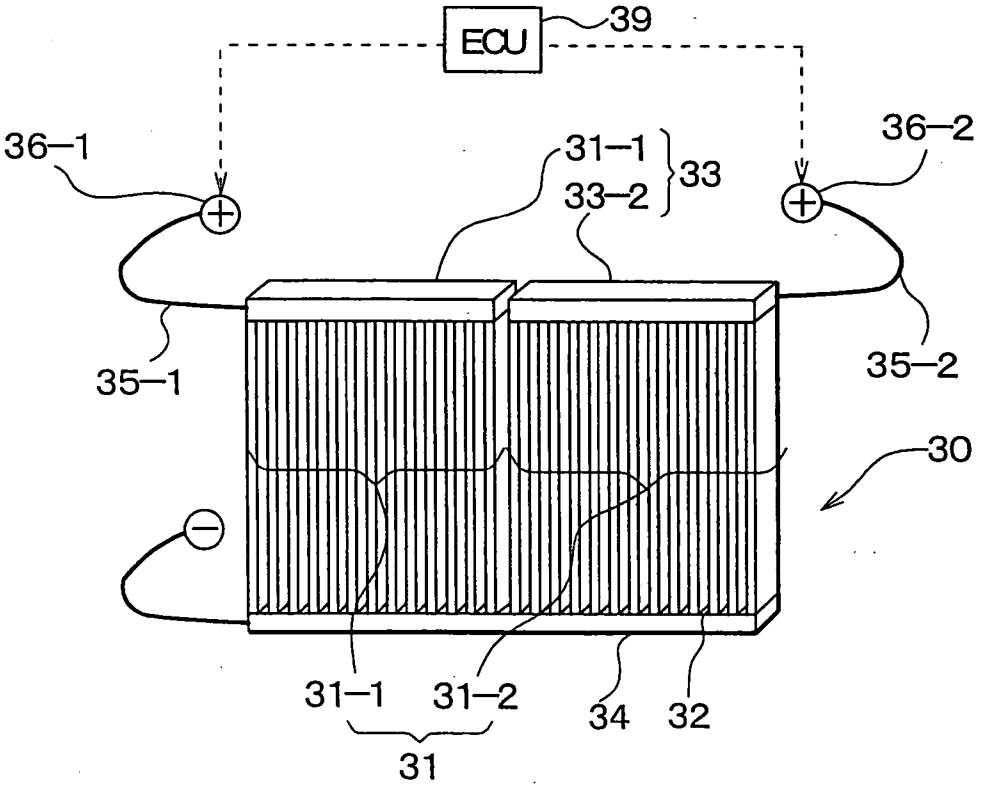
FIG. 11


ECU
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31–1
31–2
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FIG. 12

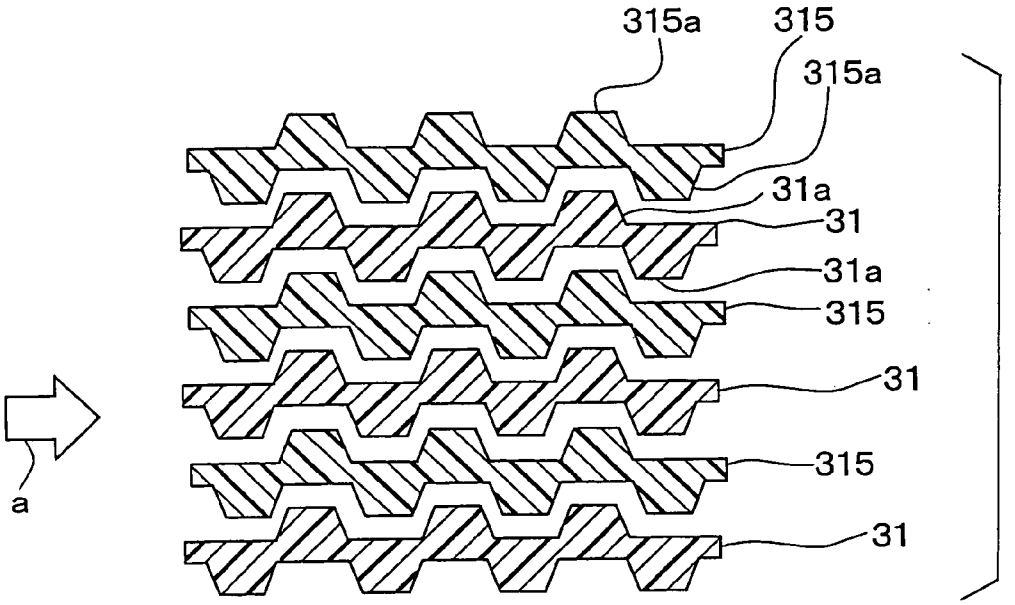
315a
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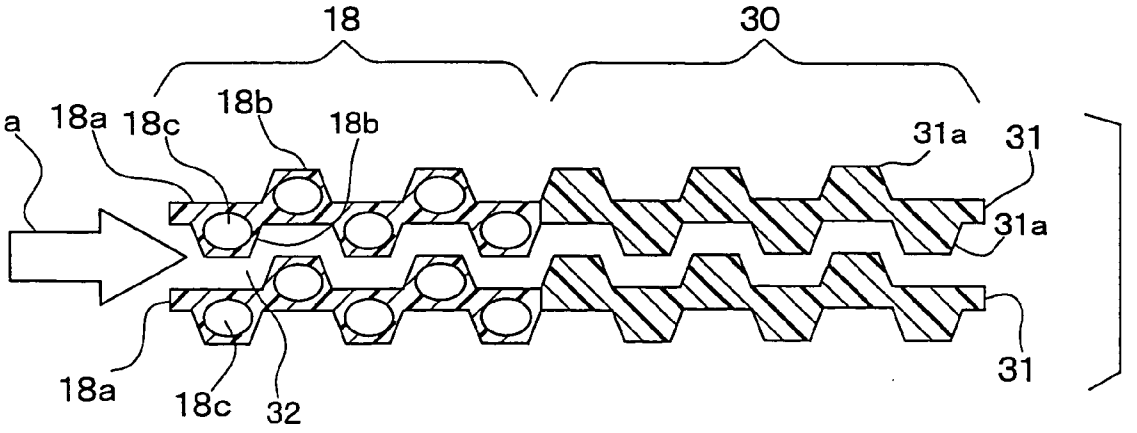
FIG. 13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ELECTRICAL HEATER, HEATING HEAT EXCHANGER AND VEHICLE AIR CONDITIONER

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is based on Japanese Patent Application No. 2003-165110 filed on Jun 10, 2003, the disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to an electrical heater, a heating heat exchanger including a heater core integrated with the electrical heater, and an air conditioner for a vehicle using the electrical heater or the heating heat exchanger.

BACKGROUND OF THE INVENTION

[0003] Various kinds of electrical heaters having an electric heating body for generating heat by flowing an electric current through this electric heating body are conventionally proposed (e.g., JP-B2-3274234). In this prior art, a PTC heating body manufactured by ceramic and suddenly increased in an electric resistance value at a predetermined temperature is used as the electric heating body, and the heating temperature can be self-controlled to the predetermined temperature.

[0004] Because the PTC heating body is manufactured by ceramic, the freedom degree of the selection of a molding shape is low. Therefore, a fin member for improving a heat radiating property must be set separately from the PTC heating body heater. In the above prior art, a gate fin is combined with the PTC heating body heater through a metallic plate, and heat exchange of the PTC heating body and air is performed through this gate fin.

[0005] The generation heat of the PTC heating body is thermally conducted to the corrugate fin through the metallic plate and is radiated from the corrugated fin to air. Accordingly, for example, even when the heat is generated in the PTC heating body itself at 160° C., the temperature is reduced until about 110° C. in the corrugated fin by the existence of the above heat transmission path. As this result, fin efficiency is reduced and heat radiating performance becomes worse.

[0006] Further, a mechanism for pressing and closely attaching the PTC heating body, the metallic plate and the corrugated fin by an elastic member such as a spring, etc. is set to preferably improve the thermal conduction from the PTC heating body to the corrugated fin. Therefore, the structure of this heater becomes complicated.

SUMMARY OF THE INVENTION

[0007] In view of the above-described problems, it is an object of the present invention to provide an electrical heater which effectively improves heat radiating performance while having a simple structure.

[0008] According to an aspect of the present invention, an electrical heater includes a plurality of heating body plates arranged in parallel with each other to define an air passage through which air flows between adjacent two thereof, a positive electrode member joined to one end side of each heating body plate, and a negative electrode member joined to the other end side of each heating body plate. In the electrical heater, the heating body plates are arranged to directly heat air passing through the air passage when electrical power is supplied to the heating body plates through the electrode members. In the present invention, because the heating body plates directly define the air passage through which air flows to directly heat air flowing through the air passage, heat radiating performance of the electrical heater can be improved while the electrical heater has a simple structure. Each of the heating body plates can be formed to have a flat shape or a wave shape. When the heating body plates are arranged in such a manner that the wave shape is bent in a direction perpendicular to an air flow direction in the air passage, heat transmitting performance of air can be effectively improved in the electrical heater. Alternatively, each of the heating body plates has protrusion portions protruding from at least one of face and back surfaces of each heating body plate to the air passage.

[0009] For example, the positive electrode member is arranged at one end side of each heating body plate in the air flow direction, and the negative electrode member is arranged at the other end side of each heating body plate in the air flow direction. Further, each of the heating body plates can be molded by using an electrically conductive resin in which an electrically conductive filler is mixed to have an electrical conductivity. Generally, the electrically conductive resin has a positive resistance temperature characteristic in which an electrical resistance increases at a predetermined temperature or more. In addition, each of the heating body plates is molded integrally with the positive electrode member and the negative electrode member.

[0010] According to another aspect of the present invention, an electrical heater includes a single heating body plate bent in a spiral shape by interposing an air gap portion at a predetermined interval so as to define air passages by using the air gap portion, a positive electrode member joined to one end side of the heating body plate, and a negative electrode member joined to the other end side of the heating body plate. In addition, the heating body plate is disposed to directly heat air passing through the air passages when electrical power is supplied to the heating body plate through the electrode members. In this case, the structure of the electrical heater can be made simple while the radiating performance of the electrical heater can be improved. Even in this case, the positive electrode member can be arranged at one end side of the heating body plate in an air flow direction of the air passages, and the negative electrode member can be arranged at the other end side of the heating body plate in the air flow direction. In this case, the resistance value of the heating body plate can be set at a suitable value without relating to the length of the spiral shape in the spiral direction. Even in this case, the heating body plate can be molded integrally with the positive electrode member and the negative electrode member.

[0011] According to a further another aspect of the present invention, an electrical heater includes a block-shaped heating body having a plurality of ventilation hole through which air flows, a positive electrode member joined to one end side of the block-shaped heating body, and a negative electrode member joined to the other end side of the block-shaped heating body. In the electrical heater, the heating body is disposed to directly heat air passing through the ventilation holes when electrical power is supplied to the

heating body through the electrode members. Even in this case, the electrical heater can effectively heat air.

[0012] For example, the heating body is molded to have a rectangular parallelepiped shape by using an electrically conductive resin in which an electrically conductive filler is mixed to have an electrical conductivity, the positive electrode member is arranged at one of two opposite surfaces of the heating body parallel to an air flow direction of the ventilation holes, and the negative electrode member is arranged at the other one of the two opposite surfaces of the heating body.

[0013] The electrical heater can be suitably used for a vehicle air conditioner having a heater core which heats air to be blown into a vehicle passenger compartment by using hot water as a heating source. In this case, the electrical heater is disposed at a downstream air side of the heater core to heat air after passing through the heater core.

[0014] According to a further another aspect of the present invention, a heating heat exchanger includes a plurality of heat transfer plates arranged in parallel with each other at a predetermined interval to define an air passage through which air flows between adjacent two thereof, a plurality of heating body plates each of which is integrated with a corresponding one of the heat transfer plates. Each of the heat transfer plates has a plurality of fluid passages through which a fluid flows to heat air passing through the air passage, and the heating body plates generate heat when electrical power is supplied thereto. In the heating heat exchanger, the heat transfer plates and the heating body plates are arranged to heat air passing through the air passages by using the hot water and the generated heat as heating sources. Accordingly even when the temperature of the fluid is low, air passing through the heating heat exchanger can be effectively heated by the electrical heater.

[0015] For example, the heating body plates are made of an electrically conductive resin in which an electrically conductive filler is mixed to have an electrical conductivity, and each of heating body plates is molded integrally with the corresponding one of the heat transfer plates. In this case, the heating heat exchanger can be readily formed. The heating heat exchanger can be suitably used for a vehicle air conditioner, for example.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Other objects, features and advantages of the present invention will become more apparent from the following detailed description made with reference to the accompanying drawings, in which:

[0017] **FIG. 1** is a schematic diagram showing an interior air conditioning unit portion of an air conditioner for a vehicle according to embodiments of the present invention;

[0018] **FIG. 2** is a perspective view showing an electrical heater according to a first embodiment of the present invention;

[0019] **FIG. 3** is a disassembled perspective view showing an electrical heater according to a second embodiment of the present invention;

[0020] **FIG. 4A** is a schematic perspective view showing an example of an electrical heater according to a third embodiment of the present invention, and **FIG. 4B** is a schematic side view showing another example of the electrical heater according the third embodiment;

[0021] **FIGS. 5A** to **5**E are cross-sectional views showing shape examples of a heating body plate of an electrical heater according to a fourth embodiment of the present invention;

[0022] **FIG. 6A** is a perspective view showing the electrical heater according to the fourth embodiment, and **FIG. 6B** is a cross-sectional view in the section VIB in **FIG. 6A**;

[0023] **FIG. 7A** is a front view showing an electrical heater according to a fifth embodiment of the present invention, and **FIG. 7B** is a cross-sectional view showing a heating body plate of the electrical heater according to the fifth embodiment;

[0024] **FIG. 8** is a front view showing an electrical heater according to a sixth embodiment of the present invention;

[0025] **FIG. 9** is a perspective view showing an electrical heater according to a seventh embodiment of the present invention;

[0026] **FIG. 10** is a front view showing an electrical heater according to an eighth embodiment of the present invention;

[0027] **FIG. 11** is a perspective view showing an electrical heater according to a ninth embodiment of the present invention;

[0028] **FIG. 12** is a cross-sectional view showing an electrical heater according to a tenth embodiment of the present invention; and

[0029] **FIG. 13** is a cross-sectional view showing a main part of an integrated structure of a hot-water type heating heat exchanger and an electrical heater, according to an eleventh embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0030] In the following embodiments, the present invention is typically used for an air conditioner for a vehicle.

First Embodiment

[0031] The first embodiment of the present invention will be now described with reference to **FIGS. 1 and 2**. An air conditioner for a vehicle using an electrical heater of the first embodiment will first be described. **FIG. 1** shows the schematic structure of an interior air conditioning unit portion **10** of the air conditioner for a vehicle. This interior air conditioning unit portion **10** is normally mounted to the inside of an unillustrated vehicle dashboard (instrument board) located in the forefront portion of a vehicle passenger compartment. An outside air introducing inlet **11**, inside air introducing inlets **12**, **13**, and inside and outside air switching doors **14**, **15** for opening and closing these introducing inlets **11**, **12**, **13** are arranged in the most upstream portion of an air flow of this interior air conditioning unit portion **10**.

[0032] Outside air (i.e., air outside the vehicle passenger compartment) or inside air (i.e., air inside the vehicle passenger compartment) introduced from the introducing inlets **11**, **12**, **13** is blown toward the vehicle passenger compartment through an air passage of an air conditioning case **10***a* of the interior air conditioning unit portion **10** by

a blower **16**. In the blower **16**, a centrifugal type blowing fan **16***a* is operated by a motor **16***b*.

[**0033**] A cooling heat exchanger **17** (i.e., heat exchanger for cooling) is arranged on a downstream side of the blower **16** within the air conditioning case **10***a*. This cooling heat exchanger **17** is constructed with an evaporator of a well-known refrigerating cycle. A heating heat exchanger **18** (i.e., heat exchanger for heating) is arranged on a downstream side of the cooling heat exchanger **17**.

[**0034**] This heating heat exchanger **18** is a heat exchanger of a hot water type (heater core) for heating the air after passing through the cooling heat exchanger **17** by using hot water (engine cooling water) from an unillustrated vehicle engine as a heat source. Further, an electrical heater **30** for immediately heating the vehicle passenger compartment is arranged in a part just after the air of the heating heat exchanger **18** is blown out. Therefore, air after passing through the heating heat exchanger **18** is heated by the electrical heater **30**.

[**0035**] A cool air passage **19** is formed on one side of the heating heat exchanger **18** within the air conditioning case **10***a*. In the cool air passage **19**, the air (cool air) after passing through the cooling heat exchanger **17** flows while bypassing the heating heat exchanger **18**. An air mix door **20** constructed with a rotatable plate door is arranged between the cooling heat exchanger **17** and the heating heat exchanger **18**. This air mix door **20** adjusts the temperature of the blowing-out air to the vehicle passenger compartment by adjusting a flow ratio of warm air passing through the heating heat exchanger **18** and cool air passing through the cool air passage **19**.

[**0036**] The conditioned air adjusted in temperature by the air mix door **20** is blown out into the vehicle passenger compartment from one or plural ports of a defroster blowing-out port **21**, a face blowing-out port **22** and a foot blowing-out port **23**. Here, the defroster blowing-out port **21** blows out the conditioned air toward a front window glass (front windshield) of the vehicle. The face blowing-out port **22** blows out the conditioned air toward the upper half body of a passenger in the vehicle passenger compartment. The foot blowing-out port **23** blows out the conditioned air toward the foot side of the passenger in the vehicle passenger compartment. These blowing-out ports **21**, **22**, **23** are selectively opened and closed by blowing-out mode doors **24** to **26** constructed with rotatable plate doors.

[**0037**] **FIG. 2** is a perspective view showing the electrical heater **30** in the first embodiment. In the electrical heater **30**, the plural heating body plates **31** (heat-generating plates) are spaced at a predetermined interval and are laminated and arranged in parallel with each other.

[**0038**] In this heating body plate **31**, an electrically conductive resin material is used as its material in this example. The heating body plate **31** is molded by this electrically conductive resin material in the shape of an elongated rectangular thin plate. The electrically conductive resin material is a material having the electrically conductive property and is formed by mixing an electrically conductive filler of a fine granular shape of a metal, carbon, a semiconductor, etc. into a resin material. By this electrically conductive resin material, a predetermined required electric resistance value required as the electrical heater **30** can be set.

[**0039**] For example, the heating body plate **31** has about 0.3 mm in thickness, and the mutual interval between the adjacent heating body plates **31** is set to about 2 mm. An air passage **32** for passing the air "a" is formed between the heating body plates **31** adjacent to each other at this interval.

[**0040**] Electrode members **33**, **34** are arranged in both end portions of the heating body plate **31** in its longitudinal direction (vertical direction in **FIG. 2**). The heating body plate **31** and the electrode members **33**, **34** are integrally joined to each other. Each of these electrode members **33**, **34** is a member of a plate shape molded by an electrically conductive body of copper, etc. More specifically, each of the electrode members **33**, **34** is molded in a rectangular plate shape covering the entire end portion of a laminating arrangement structure body of the plural heating body plates **31**, and are integrally joined to the end portions of all the heating body plates **31**. For example, a joining material such as silver paste excellent in the electrically conductive property is used as a joining means. The electrode members **33**, **34** and the end portions of the heating body plates **31** are integrally joined to each other through this joining material.

[**0041**] The laminating arrangement structure of the plural heating body plates **31** can be mechanically integrally held by the electrode members **33**, **34**, and both the end portions of the plural heating body plates **31** in their longitudinal direction are respectively electrically connected to the electrode members **33**, **34**. In the two electrode members **33**, **34**, a positive electrode terminal portion **36** is connected to the positive electrode member **33** on the upper side through a lead wire **35**. Further, a negative electrode terminal portion **38** is connected to the negative electrode member **34** on the lower side through a lead wire **37**. An output portion of a control device **39** (ECU) is connected to this positive electrode terminal portion **36**, and the turning-on and turning-off operations of an electric current conducted to the plural heating body plates **31** are automatically controlled by the output of the control device **39**.

[**0042**] In a heating operation of the vehicle passenger compartment in winter, the water temperature of the vehicle engine is reduced to a very low temperature similar to the outside air temperature just after the vehicle engine is started. Therefore, the heating heat exchanger **18** cannot heat air to be blown into the vehicle passenger compartment by using the hot water of the vehicle engine as a heat source. Accordingly, when only the heating heat exchanger **18** of a hot water type is used in the air conditioning unit portion **10**, the heating operation for heating the vehicle passenger compartment cannot be performed just after the vehicle engine is started. Therefore, the comfortable property in the vehicle passenger compartment is greatly damaged.

[**0043**] In this embodiment, a low temperature of the hot water (engine cooling water) in the heating operation in winter is determined by the control device **39** and the electric current conducting circuit between the positive electrode terminal portion **36** of the electrical heater **30** and an unillustrated vehicle mounting battery is automatically set to the ON state and the electric current is conducted to the heating body plate **31**. The control device **39** automatically supplies the electric current to the heating body plate **31** when it is determined that the water temperature from the engine detected by an unillustrated water temperature sensor is a predetermined temperature or less and it is an environ-

mental condition where the heating operation of the vehicle passenger compartment is required. For example, when the temperature of the vehicle passenger compartment is lower than a predetermined temperature, or when the temperature of outside air outside the vehicle passenger compartment is lower than a predetermined temperature, it is determined that the heating operation for heating the passenger compartment is required.

[0044] Since the heating body plate **31** generates heat by supplying the electric current to the heating body plate **31**, the blowing air can be directly heated by the heating body plate **31**. Even when the water from the vehicle engine is low, the interior of the vehicle passenger compartment can be also effectively immediately heated by blowing-out this heated air (warm air) of the electrical heater **30** into the vehicle passenger compartment from the foot blowing-out port **23**, etc.

[0045] The blower **16** is operated when the electric current is supplied to the motor **16***b* by an output signal of the control device **39** at a time where electrical current is supplied to the heating body plate **31**. In this case, the blowing air of the blower **16** passes through the cooling heat exchanger **17** and the heating heat exchanger **18**, and then passes through many air passages **32** between the heating body plates **31** of the electrical heater **30**.

[0046] Because the surface of each heating body plate **31** directly faces the air flow of the air passage **32** to directly contact the air, the generation heat of each heating body plate **31** can be directly transmitted to the air passing through the air passage **32**. Because a member itself corresponding to the fin located in the air flow becomes the heat generating body (heating body plate **3**), no problem of a reduction in fin efficiency is caused. Further, because the generation heat of each heating body plate **31** can be almost given to the air flow, the heat radiating performance of the electrical heater **30** can be improved. Accordingly, electric power consumption of the electrical heater **30** can be effectively reduced while heating performance of the electrical heater can be improved.

[0047] Further, because each heating body plate **31** generates heat on its entire surface, the air flowing through the air passage **32** can be uniformly heated without irregularities, and the temperature distribution of the blowing-out air can be uniformed.

[0048] Each air passage **32** is constructed with the distance between the adjacent heating body plates **31**, and the surface of each heating body plate **31** is constructed so as to directly face the air flow. Accordingly, a body separated from the heating body plate, such as a metallic plate, a fin, a spring mechanism for pressing is not required. Therefore, the structure of the electrical heater **30** can be simplified.

[0049] The electrically conductive resin material of the heating body plate **31** in this embodiment can have PTC heating body characteristics by a material composition including no Pb, and it is also advantageous in view of environmental protection.

[0050] A material obtained by mixing carbon particles as an electrically conductive filler into a crystalline polymer can be used as an example of the electrically conductive resin material having the PTC heating body characteristics. In this electrically conductive resin material, the PTC heating body characteristics appear by the following principle. That is, when the temperature of the electrically conductive resin material (heating body plate **31**) rises and approaches a crystal melting point of the crystalline polymer, the coefficient of thermal expansion of the crystalline polymer is increased. Therefore, the distances between carbon particles in the electrically conductive resin material are increased and the electric resistance value is suddenly increased (the appearance of the PTC heating body characteristics). Accordingly, the temperature of the heating body plate **31** can be self-controlled to the temperature near the crystal melting point of the crystalline polymer by suddenly reducing the electric current flowing through the heating body plate **31** at the temperature near the crystal melting point of the crystalline polymer.

Second Embodiment

[0051] The second embodiment of the present invention will be now described with reference to **FIG. 3**.

[0052] In the above-described first embodiment, the electrode members **33**, **34** are arranged in both the end portions of each of the plural heating body plates **31** in their longitudinal direction (vertical direction of **FIG. 1**). That is, the electrode members **33**, **34** extend at both the end portions of each heating body plate **31** to be parallel to the air flow direction "a". However, in the second embodiment, as shown in **FIG. 3**, electrode members **33**, **34** are arranged in two end portions of each heating body plate **31** in a short side direction (lateral direction). That is, the electrode members **33**, **34** are arranged at the upstream and downstream end portions of the heating body plates **31** in the air flow direction "a".

[0053] Therefore, in the second embodiment, joining portions **33***a*, **34***a* of a short strip shape bonded to the upstream and downstream end portions of the respective heating body plates **31**, and air gap portions **33***b*, **34***b* of a slit shape communicated with the air passages **32** between the adjacent heating body plates **31** are formed in the electrode members **33**, **34**. Accordingly, air passes through the slit-shaped air gap portions **33***b*, **34***b* of the electrode members **33**, **34** and the air passages **32** between the adjacent heating body plates **31** as shown by the arrow "a". In the second embodiment, the other parts are similar to those of the above-described first embodiment.

Third Embodiment

[0054] The third embodiment of the present invention will be now described with reference to **FIGS. 4A and 4B**.

[0055] In the above-described first and second embodiments, the heating body plate **31** and the electrode members **33**, **34** are respectively molded in advance as separate bodies, and the end portions of the plural heating body plates **31** arranged in parallel with each other are integrally joined to the electrode members **33**, **34** of the plate shape. However, in the third embodiment, as shown in **FIGS. 4A and 4B**, auxiliary electrode members **330**, **340** constructed with electrically conductive bodies of copper, etc. are integrally molded in the end portions of the respective heating body plates **31**.

[0056] Specifically, in **FIG. 4A**, the auxiliary electrode members **330**, **340** constructed with the electrically conduc-

tive bodies of copper, etc. are integrally molded with both the end portions of the respective heating body plates **31** in their longitudinal direction (vertical direction of **FIG. 1**). Further, in **FIG. 4B**, the auxiliary electrode members **330**, **340** constructed with the electrically conductive bodies of copper, etc. are integrally molded with both the end portions of the respective heating body plates **31** in their short side direction, i.e., in both the upstream and downstream end portions in the air flow direction "a".

[**0057**] When each heating body plate **31** is injection-molded, the auxiliary electrode members **330**, **340** can be integrally molded in each heating body plate **31** by an insertion molding method.

[**0058**] In the example of **FIG. 4A**, the plate-shaped electrode members **33**, **34** shown in **FIG. 2** are further integrally joined to the auxiliary electrode members **330**, **340** of each heating body plate **31**. Further, in the example of **FIG. 4B**, the plate-shaped electrode members **33**, **34** shown in **FIG. 3** are further integrally joined to the auxiliary electrode members **330**, **340** of each heating body plate **31**.

[**0059**] In accordance with the third embodiment, when the heating body plate **31** is molded by a resin material, the heating body plate **31** and the auxiliary electrode members **330**, **340** can be directly electrically joined to each other by integral molding, and the contact resistance between the heating body plate **31** and the auxiliary electrode members **330**, **340** can be reduced. Therefore, a suitable resistance value can be set as the entire electrical heater even when the resistance value proper to the electrically conductive resin constituting the heating body plate **31** is large.

[**0060**] Both the auxiliary electrode members **330**, **340** and the electrode members **33**, **34** are constructed with electrically conductive bodies of copper, etc., and the electrically conductive bodies contact with each other and are joined to each other. Accordingly, the contact resistance of this electrode joining portion can be greatly reduced.

[**0061**] Further, in the example of **FIG. 4B**, an inter-electrode distance L2 between the electrode members **330**, **340** can be set to be sufficiently smaller than an inter-electrode distance L1 between the electrode members **330**, **340** in the example of **FIG. 4A**. Thus, the resistance value of the entire electrical heater can be set to a suitable resistance value even when the resistance value of the electrically conductive resin constituting the heating body plate **31** is large.

[**0062**] In **FIGS. 4A and 4B**, the examples in which the auxiliary electrode members **330**, **340** are integrally molded to each heating body plate **31**, has been described. However, the electrode members **33**, **34** of the plate shape shown in **FIG. 2** can be integrally molded with both the end portions of the plural heating body plates **31** in their longitudinal direction, instead of the corresponding auxiliary electrode members **330**, **340** every each heating body plate **31**. Further, the electrode members **33**, **34** of the plate shape shown in **FIG. 3** can be integrally molded in both the end portions of the heating body plates **31** in their short side direction (both the upstream and downstream end portions in the air flow direction "a").

Fourth Embodiment

[**0063**] The fourth embodiment of the present invention will be now described with reference to **FIGS. 5A-5E** and **FIG. 6A-6B**.

[**0064**] In each of the first to third embodiments, the heating body plate **31** is formed in the shape of a simple flat plate. However, in the fourth embodiment, the heat radiating performance of the heating body plate **31** is improved by changing the shape of the heating body plate **31**.

[**0065**] **FIG. 5A** shows a first example of the fourth embodiment. In this first example of the fourth embodiment, the heating body plate **31** is bent and molded in a wavy shape along the air flow direction "a". In accordance with this heating body plate **31**, the air flow is effectively disturbed by the wavy shape so that the heat transfer rate can be improved and the heat transfer area can be effectively increased.

[**0066**] **FIG. 5B** shows a second example of the fourth embodiment. In this second example of the present invention, plural hemispherical projections **31***a* are projected and formed along the air flow direction "a" from one side of a flat plate reference face of the heating body plate **31**. In accordance with such a structure, the air flow is disturbed by the hemispherical projection **31***a*, and the heat transfer rate can be improved and the heat transfer area can be increased.

[**0067**] **FIG. 5C** shows a third example of the fourth embodiment. In the third example of the fourth embodiment, the hemispherical projections **31***a* of the above second example are alternately projected and formed on both the front and rear sides from the flat plate reference face of the heating body plate **31** along the air flow direction "a".

[**0068**] **FIG. 5D** shows a fourth example of the fourth embodiment. In the fourth example of the fourth embodiment, a triangular projection **31***a* is projected and formed instead of the hemispherical projection **31***a* of the above second example. Further, **FIG. 5E** shows a fifth example of the fourth embodiment. In the fifth example of the fourth embodiment, a rectangular projection **31***a* is projected and is formed instead of the hemispherical projection **31***a* of the above second example.

[**0069**] **FIG. 6A** shows an electrical heater **30** in which heating body plates **31** having the hemispherical projections **31***a* of FIG. 5C are laminated and arranged in parallel with each other as shown in **FIG. 6B**. Each of **FIGS. 5B** to **5E** illustrates a sectional shape in which a concave portion is formed inside the projection **31***a*, but a solid projecting shape having no concave portion inside the projection **31***a* can be also formed.

[**0070**] In the above-described fourth embodiment of the present invention, the heating body plates **31** can be arranged in such a manner that the wave shape is bent in a direction perpendicular to the air flow direction in the air passages **32**. Further, the positive electrode member **33 (330)** can be arranged at one end side of the heating body plates **31**, and the negative electrode member **34 (340)** can be arranged at the other end side of each heating body plate in the air flow direction.

Fifth Embodiment

[**0071**] The fifth embodiment of the present invention will be now described with reference to **FIGS. 7A and 7B**.

[**0072**] As shown in **FIG. 7A**, within a rectangular frame body **40**, heating body plates **31** molded to be bent in a wavy shape as shown in **FIG. 5A** are laminated and arranged by many stages (six stages in the illustrated example) through

a support plate **41** between the adjacent heating body plates **31**. Each of the support plates **41** is manufactured from resin. An air passage **32** is formed by an air gap portion (clearance) formed by the wavy shape of the heating body plate **31**.

[**0073**] Accordingly, air passes through a rectangular opening portion of the frame body **40** and the air gap portion (air passage **32**) formed by the wavy shape of the heating body plate **31**, and flows in the direction perpendicular to the paper sheet face of **FIG. 7A**. In this example, as shown in **FIG. 7B**, auxiliary electrode members **330**, **340** are integrally molded with both the end portions of each heating body plate **31** in the air flow direction "a" (the direction perpendicular to the paper sheet face of **FIG. 7A**). Accordingly, the electrode arranging structure in the fifth embodiment has the same relation as **FIG. 4B** with respect to the air flow direction "a". Here, the auxiliary electrode member **330** as one of both the auxiliary electrode members **330**, **340** is set as a positive electrode and the other auxiliary electrode member **340** is set as a negative electrode.

[**0074**] A positive electrode member **33** is electrically joined to the positive auxiliary electrode member **330** of each heating body plate **31** and a negative electrode member **34** is electrically joined to the negative auxiliary electrode member **340** of each heating body plate **31**. The positive electrode member **33** and the negative electrode member **34** are arranged in a frame portion **40***a* located on the left-hand side of **FIG. 7A** within the frame body **40**, i.e., within the frame portion **40***a* located on one end side of the wavy shape of the heating body plate **31**. In **FIG. 7A**, both these electrode members **33**, **34** are not illustrated. However, similar to the electrode members in **FIG. 2**, both these electrode members **33**, **34** are connected to terminal portions **36**, **38** through lead wires **35**, **37**. Accordingly, both the electrode members **33**, **34** provided within the frame portion **40***a* have functions in an electrical circuit, similarly to that in **FIG. 2**.

Sixth Embodiment

[**0075**] The sixth embodiment of the present invention will be now described with reference to **FIG. 8**. In the sixth embodiment, only a single heating body plate **31** bent and molded in a wavy shape is arranged within the rectangular frame body **40** manufactured by resin. All the other points are the same as the fifth embodiment.

[**0076**] In accordance with the fifth and sixth embodiments, at least the heating body plates **31**, the auxiliary electrode members **330**, **340** and the unillustrated electrode members **33**, **34** are arranged within the rectangular frame body **40** manufactured by resin. Accordingly, the heating body plate **31** and the electrode members **33**, **34**, **330**, **340** can be protected by the frame body **40**. Further, since the heating body plate **31** is bent and molded in the wavy shape, the heat transfer area of the heating body plate **31** can be effectively increased.

Seventh Embodiment

[**0077**] The seventh embodiment of the present invention will be now described with reference to **FIG. 9**.

[**0078**] In each of the above embodiments, the electrical heater **30** is constructed by using the heating body plate **31** having the plate shape. However, in the seventh embodiment, as shown in **FIG. 9**, a heating body **310** (heat-generating member) of a block shape having many ventilation holes **311** for forming air passages is molded by using electrically conductive resin so as to form the electrical heater **30**.

[**0079**] More specifically, the heating body **310** is molded in a rectangular parallelepiped shape, and many ventilation holes **311** penetrating through this rectangular parallelepiped body in the air flow direction "a" are bored in parallel with each other. A positive electrode member **33** is arranged in an upper face portion of the heating body **310** and is electrically joined to this upper face portion of the heating body **310**. Further, a negative electrode member **34** is arranged in a lower face portion of the heating body **310** and is electrically joined to this lower face portion of the heating body **310**. Similar to the electrode members in **FIG. 2**, both these electrode members **33**, **34** are connected to terminal portions **36**, **38** through lead wires **35**, **37**.

[**0080**] In accordance with the seventh embodiment, because air passes through the ventilation holes **311** of the heating body **310**, the inner wall face of the heating body **310**, defining many ventilation holes **311**, becomes a heating portion (a heat radiating portion to the air). Therefore, air passing through the ventilation holes **311** can be efficiently heated.

[**0081**] Further, the structure of the electrical heater **30** can be simplified because the heating body **310** of the electrical heater **30** can be constructed with the single rectangular parallelepiped block that is integrally molded.

[**0082**] Each of **FIGS. 2**, **3**, **6** and **9** shows only the arrangement structure of the heating body plate **31** or the block-shaped heating body **310** and both the electrode members **33**, **34**. However, in the embodiment of each of these figures, the heating body plate **31** or the block-shaped heating body **310** and both the electrode members **33**, **34** can be also arranged within the rectangular frame body **40** manufactured by resin and shown in **FIGS. 7A and 8**. In this case, these members **31**, **310**, **33**, **34** can be protected by using the frame body **40**.

Eighth Embodiment

[**0083**] The eighth embodiment of the present invention will be now described with reference to **FIG. 10**. In this eighth embodiment, the heating body plate **31** is arranged within the rectangular frame body **40** in a rectangular spiral shape by interposing an air gap portion at a predetermined interval. The rectangular frame body **40** is made of resin. An air passage **32** for passing the air is formed by the spiral air gap portion. That is, a single heating body plate **31** is formed in the spiral shape to have the air gap portion between the formed spiral plate parts of the single heating body plate **31**. In this example shown in **FIG. 10**, the single heating body plate is bent in the rectangular spiral shape. However, the single heating body plate can be bent in the other spiral shape. In the eighth embodiment, similar to **FIG. 7B**, auxiliary electrode members **330**, **340** are integrally molded in both end portions of the heating body plate **31** in the air flow direction "a" (the direction perpendicular to the paper sheet face of **FIG. 10**). These auxiliary electrode members **330**, **340** are electrically connected to lead wires **35**, **37** through electrode members **33**, **34** (not shown in **FIG. 10**) arranged within the frame portion **40***a* of the frame body **40**.

[0084] In accordance with the eighth embodiment, air passing through the air passage **32** of the spiral shape can be directly efficiently heated by the heating body plate **31** of the spiral shape.

[0085] In the eighth embodiment, the heating body plate **31** can have protrusion portions protruding from at least one of face and back surfaces of the heating body plate to the air passage. Further, the heating body plate can be molded by using an electrically conductive resin in which an electrical conductive filler is mixed to have an electrical conductivity. For example, the electrically conductive resin has a positive resistance temperature characteristic in which an electrical resistance increases at a predetermined temperature or more.

[0086] Further, the heating body plate **31** can be molded integrally with the positive electrode member **33** and the negative electrode member **34**. In addition, it is also possible to independently control electrical power to be supplied to plural areas of the heating body plate **31**.

Ninth Embodiment

[0087] In each of the above embodiments, only the positive electrode terminal portion **36** and the negative electrode terminal portion **38** are connected to the heating body plate **31** or the block-shaped heating body **310**. In this case, the turning-on and turning-off operations of the heating body plate **31** or the block-shaped heating body **310** are controlled by the control device **39** (**FIG. 2**) through both the terminal portions **36**, **38**.

[0088] In contrast to this, in the ninth embodiment, the heating body plate **31** is partitioned into plural areas, and the current control operation of each heating body plate **31** in these plural areas can be independently performed.

[0089] In the ninth embodiment, as shown in **FIG. 11**, the positive electrode member **33** located in the upper end portions of the plural heating body plates **31** is divided into a positive electrode part **33-1** on the left-hand side and a positive electrode part **33-2** on the right-hand side. An air gap having a predetermined interval is provided between both these left and right positive electrode parts **33-1** and **33-2**, and electrically insulates these left and right positive electrode parts **33-1** and **33-2** from each other.

[0090] The plural heating body plates **31** are also partitioned into heating body plates **31-1** on the left-hand side electrically joined to the positive electrode part **33-1**, and heating body plates **31-2** on the right-hand side electrically joined to the positive electrode part **33-2**. Both the lower end portions of each heating body plate **31-1** on the left-hand side and each heating body plate **31-2** on the right-hand side are electrically joined to a common negative electrode member **34**.

[0091] The positive electrode part **33-1** on the left-hand side is connected to a positive electrode terminal portion **36-1** on the left-hand side through a left-hand side lead wire **35-1**. The positive electrode part **33-2** on the right-hand side is connected to a positive electrode terminal portion **36-2** on the right-hand side through a right-hand side lead wire **35-2**. Voltages applied to these left and right positive electrode terminal portions **36-1**, **36-2** are independently controlled by the control device **39**.

[0092] Accordingly, the heating amount of the heating body plates **31-1** on the left-hand side and the heating amount of the heating body plates **31-2** on the right-hand side can be independently controlled by the output of the control device **39**. Therefore, the blowing-out temperature of air on the left-hand side area and the blowing-out temperature of air on the right-hand side area in the electrical heater **30** can be independently controlled in accordance with the requests of passengers in the immediate heating operation.

[0093] In **FIG. 11**, left and right independent control of air blown out from the electrical heater **30** has been described. However, the heating body plates **31** of the electrical heater **30** can be partitioned into four areas constructed with upper and lower and left and right areas. In this case, the heating amounts of the heating body plates **31** in the four areas can be independently controlled.

[0094] In **FIG. 11**, the plural heating body plates **31** are arranged in parallel with each other. However, when the heating body block **310** of **FIG. 9** is used, similar effects can be also obtained if the heating body block **310** is divided into plural block parts and the current flowing operations of these plural heating body blocks **310** can be independently controlled.

Tenth Embodiment

[0095] The tenth embodiment of the present invention will be now described with reference to **FIG. 12**. In the tenth embodiment, as shown in **FIG. 12**, a heating body plate **31** made of electrically conductive resin and a non-heating body plate **315** made of normal resin (electric insulating material) are alternately arranged in parallel with each other. Similarly to **FIG. 5C**, projecting portions **31***a*, **315***a* are formed in the heating body plate **31** and the non-heating body plate **315** and are alternately projected onto both the front and rear faces so as to disturb the air flow of the air passage **32**. In the example of **FIG. 12**, the projecting shapes of the projecting portions **31***a*, **315***a* are set to trapezoidal solid shapes.

[0096] In accordance with the tenth embodiment, the electrical heater **30** having a different heating amount can be easily obtained by selecting the number of heating body plates **31** in accordance with a required heating amount while the size of the electrical heater **30** is constantly maintained.

Eleventh Embodiment

[0097] In the eleventh embodiment, as shown in **FIG. 13**, a heating heat exchanger **18** (heater core) of a hot water type shown in **FIG. 1** and the electrical heater **30** are integrally formed to construct a heat exchanger for heating air.

[0098] Plural (only two is shown in **FIG. 13**) heat transfer plate members **18***a* of the heating heat exchanger **18** are arranged in parallel with each other at a predetermined interval, and an air passage **32** is formed between these heat transfer plate members **18***a*. Further, projecting portion **18***b* are formed in the heat transfer plate member **18***a* and are alternately projected in a trapezoidal shape from both the front and rear faces of the heat transfer plate member **18***a* onto the air passage **32**. A water passage **18***c* of a circular shape in cross-section for flowing hot water (engine cooling water) is formed in the inside portion of each projecting portion **18***b*. This water passage **18***c* is extended in the direction perpendicular to the air flow direction "a".

[0099] The heating body plate **31** of the electrical heater **30** is integrally formed with the transfer plate member **18***a* of the heating heat exchanger **18** at a downstream end portion of the heat transfer plate member **18***a* of the heating heat exchanger **18** in an air flow direction "a". Similarly to the heat transfer plate member **18***a*, trapezoidal projecting portions **31***a* are formed in the heating body plate **31**. In this example shown in **FIG. 13**, each of the projection portions **31***a* is a solid projection without a hollow.

[0100] The heat transfer plate member **18***a* is made of resin such as polyamide resin having an excellent heat resisting property. Accordingly, the heat transfer plate member **18***a* and the heating body plate **31** can be integrally molded by a method of two-color molding.

[0101] The coefficient of thermal conductivity of the resin material constituting the heat transfer plate member **18***a* is very lower than that of a metal such as aluminum, etc. However, the present inventors have confirmed that a reduction in heating performance (heat radiating amount) can be restrained to a very small value by setting the plate thickness of a portion around the water passage **18***c* of the heat transfer plate member **18***a* to a small value such as about in a range between 0.1 and 0.4 mm in comparison with a case in which the heat transfer plate member **18***a* is constructed with aluminum.

[0102] In the eleventh embodiment, in a case where the immediate heating operation is performed by flowing the electric current through the heating body plate **31**, when the generation heat of the heating body plates **31** is adsorbed to the low temperature water within the water passages **18***c*, a problem is caused in that no air of the air passage **32** can be efficiently heated by the generation heat of the heating body plates **31**. However, the heat transfer plate member **18***a* is not constructed with a metal but is constructed with the resin material and the coefficient of thermal conductivity is very low. Thus, no heat movement to the low temperature water is almost caused even when the heat transfer plate member **18***a* and the heating body plate **31** are integrally molded. Accordingly, the air passing through the air passage **32** can be efficiently heated by the generation heat of the heating body plate **31**.

[0103] Both end portions of each water passage **18***c* of the heat transfer plate member **18***a* (both end portions in the direction perpendicular to the paper sheet face of **FIG. 13**) are connected to unillustrated water inlet and outlet side tank portions so that the water (hot water) from the vehicle engine (a vehicle-mounted hot water source) is circulated in each water passage **18***c* of the heat transfer plate member **18***a*. Namely, the hot water from the vehicle engine is flowed from the hot water inlet side tank portion into one end portion of each water passage **18***c*. When this flowed-in hot water passes through the water passage **18***c*, the flowed-in hot water is thermally exchanged with the air of the air passage **32** so that the air passing through the heating heat exchanger is heated. The hot water after performing the heat exchange with the air flows from the other end portion of each water passage **18***c* into the water outlet side tank portion, and is returned from this water outlet side tank portion to the vehicle engine side.

Other Embodiments

[0104] Although the present invention has been fully described in connection with the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications will become apparent to those skilled in the art.

[0105] For example, in each of the above embodiments of the present invention, the electrically conductive resin is used as concrete materials of the heating body plate **31** and the block-shaped heating body **310**. However, in addition to the electrically conductive resin, a metallic electric resistance material such as a nickel chromium alloy, etc. or a semiconductor can be used as the materials of the heating body plate **31** and the block-shaped heating body **310**.

[0106] In each of the above embodiments, it is not described that surface processing of the heating body plate **31** and the block-shaped heating body **310** is performed. However, a surface processing layer can be formed for the purpose of electric insulation, waterproof, etc. in a thin film shape on the surfaces of the heating body plate **31** and the block-shaped heating body **310**.

[0107] The electrical heater in the present invention is not limited to be used for the vehicle air conditioner, but can be used for various devices.

[0108] Such changes and modifications are to be understood as being within the scope of the present invention as defined by the appended claims.

What is claimed is:

1. An electrical heater comprising:

a plurality of heating body plates arranged in parallel with each other, to define an air passage through which air flows between adjacent two thereof;

a positive electrode member joined to one end side of each heating body plate; and

a negative electrode member joined to the other end side of each heating body plate,

wherein the heating body plates are arranged to directly heat air passing through the air passage when electrical power is supplied to the heating body plates through the electrode members.

2. The electrical heater according to claim 1, wherein each of the heating body plates has a flat shape.

3. The electrical heater according to claim 1, wherein each of the heating body plates is molded to have a wave shape.

4. The electrical heater according to claim 3, wherein:

the heating body plates are arranged in such a manner that the wave shape is bent in a direction perpendicular to an air flow direction in the air passage;

the positive electrode member is arranged at one end side of each heating body plate in the air flow direction; and

the negative electrode member is arranged at the other end side of each heating body plate in the air flow direction.

5. The electrical heater according to claim 1, wherein each of the heating body plates has protrusion portions protruding from at least one of face and back surfaces of each heating body plate to the air passage.

6. The electrical heater according to claim 1, wherein each of the heating body plates is molded by using an electrically conductive resin in which an electrically conductive filler is mixed to have an electrical conductivity.

7. The electrical heater according to claim 6, wherein the electrically conductive resin has a positive resistance temperature characteristic in which an electrical resistance increases at a predetermined temperature or more.

8. The electrical heater according to claim 1, wherein each of the heating body plates is molded integrally with the positive electrode member and the negative electrode member.

9. The electrical heater according to claim 1, wherein each of the heating body plates is partitioned into plural areas, the electrical heater further comprising

a control device which independently controls the electrical power to be supplied to the plural areas of the heating body plates.

10. An electrical heater comprising:

a single heating body plate bent in a spiral shape by interposing an air gap portion at a predetermined interval, so as to define air passages by using the air gap portion;

a positive electrode member joined to one end side of the heating body plate; and

a negative electrode member joined to the other end side of the heating body plate,

wherein the heating body plate is disposed to directly heat air passing through the air passages when electrical power is supplied to the heating body plate through the electrode members.

11. The electrical heater according to claim 10, wherein:

the positive electrode member is arranged at one end side of the heating body plate in an air flow direction of the air passages; and

the negative electrode member is arranged at the other end side of the heating body plate in the air flow direction.

12. The electrical heater according to claim 10, wherein the heating body plate has protrusion portions protruding from at least one of face and back surfaces of the heating body plate to the air passage.

13. The electrical heater according to claim 10, wherein the heating body plate is molded by using an electrically conductive resin in which an electrically conductive filler is mixed to have an electrical conductivity.

14. The electrical heater according to claim 13, wherein the electrically conductive resin has a positive resistance temperature characteristic in which an electrical resistance increases at a predetermined temperature or more.

15. The electrical heater according to claim 10, wherein the heating body plate is molded integrally with the positive electrode member and the negative electrode member.

16. The electrical heater according to claim 10, wherein the heating body plate is partitioned into plural areas, the electrical heater further comprising

a control device which independently controls the electrical power to be supplied to the plural areas.

17. An electrical heater comprising:

a block-shaped heating body having a plurality of ventilation hole through which air flows;

a positive electrode member joined to one end side of the block-shaped heating body; and

a negative electrode member joined to the other end side of the block-shaped heating body,

wherein the heating body is disposed to directly heat air passing through the ventilation holes when electrical power is supplied to the heating body through the electrode members.

18. The electrical heater according to claim 17, wherein:

the heating body is molded to have a rectangular parallelepiped shape by using an electrically conductive resin in which an electrically conductive filler is mixed to have an electrical conductivity;

the positive electrode member is arranged at one of two opposite surfaces of the heating body, parallel to an air flow direction of the ventilation holes; and

the negative electrode member is arranged at the other one of the two opposite surfaces of the heating body.

19. A vehicle air conditioner having the electrical heater according to claim 1, the vehicle air conditioner comprising

a heater core which heats air to be blown into a vehicle passenger compartment by using hot water as a heating source, wherein the electrical heater is disposed at a downstream air side of the heater core to heat air after passing through the heater core.

20. A heating heat exchanger comprising:

a plurality of heat transfer plates arranged in parallel with each other at a predetermined interval, to define an air passage through which air flows between adjacent two thereof, each of the heat transfer plates having a plurality of fluid passages through which a fluid flows to heat air passing through the air passage; and

a plurality of heating body plates each of which is integrated with a corresponding one of the heat transfer plates, the heating body plates generate heat when electrical power is supplied thereto,

wherein the heat transfer plates and the heating body plates are arranged to heat air passing through the air passages by using the hot water and the generated heat as heating sources.

21. The heating heat exchanger according to claim 20, wherein:

the heating body plates are made of an electrically conductive resin in which an electrically conductive filler is mixed to have an electrical conductivity; and

each of heating body plates is molded integrally with the corresponding one of the heat transfer plates.

22. The heating heat exchanger according to claim 20, wherein the heating body plates are arranged to directly heat air when electrical power is supplied to the heating body plates.

23. A vehicle air conditioner including the heating heat exchanger according to claim 20, wherein the heating heat exchanger is disposed to heat air to be blown into a vehicle passenger compartment.

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