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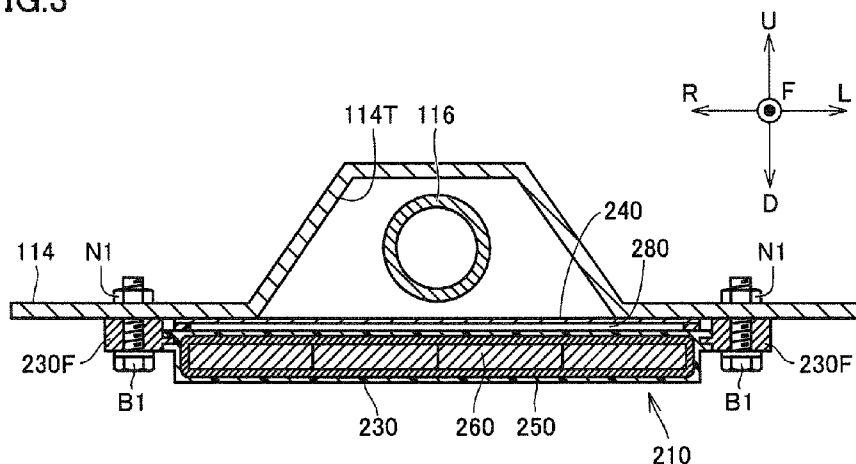
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(54) Title: POWER RECEPTION DEVICE, POWER TRANSMISSION DEVICE AND VEHICLE

FIG.3



(57) Abstract: A power reception unit (210) includes: a core unit (260) having a plate-like shape and including a side surface, an upper surface and a lower surface; a power reception coil (250) spirally wound around a perimeter of the core unit (260); a resin member (230) having a plate-like shape having a side surface, an upper surface and a lower surface, and having the core unit (260) and the power reception coil (250) embedded therein; a shield (240) arranged on the upper surface side of the resin member (230) with a spacing therebetween; and a heat insulating layer (280) arranged between the shield (240) and the upper surface of the resin member (230), and having better heat insulation performance than that of the resin member (230).

Description

Title of Invention: POWER RECEPTION DEVICE, POWER TRANSMISSION DEVICE AND VEHICLE

Technical Field

[0001] The present invention relates to a power reception device and a power transmission device that receive and transmit electric power in a contactless manner, and a vehicle including the power reception device.

Background Art

[0002] As disclosed in PTLs 1 to 6, there are known a power reception device and a power transmission device that receive and transmit electric power in a contactless manner. A power reception device including a power reception unit disclosed in PTL 1 (Japanese Patent Laying-Open No. 2013-154815; refer to Fig. 9) includes a shield case being open toward the lower side, a lid made of resin and provided to close an opening of the shield case, a core unit having a ferrite core provided within the shield case, and a power reception coil wound around the core unit. A power transmission device also has a similar configuration.

[0003] According to a power reception device and a power transmission device disclosed in PTL 2 (Japanese Patent Laying-Open No. 2013-132171), there is disclosed a structure of a shield whose shape is designed to suppress leakage of an electromagnetic field to the surroundings.

Citation List

Patent Literature

- [0004] [PTL 1] Japanese Patent Laying-Open No. 2013-154815
- [PTL 2] Japanese Patent Laying-Open No. 2013-132171
- [PTL 3] Japanese Patent Laying-Open No. 2013-146154
- [PTL 4] Japanese Patent Laying-Open No. 2013-146148
- [PTL 5] Japanese Patent Laying-Open No. 2013-110822
- [PTL 6] Japanese Patent Laying-Open No. 2013-126327

Summary of Invention

Technical Problem

[0005] In order to reduce the number of components and enhance the heat release performance to the outside, it is conceivable to adopt such a structure that a power reception coil is wound around a core unit (ferrite core) and the core unit and the power reception coil are sealed with resin.

[0006] In the case where the resin-sealed structure is used in a power reception device and a

shield is arranged on an upper surface of this structure, a magnetic flux formed around the power reception coil during reception of electric power passes through the shield. At this time, an eddy current is generated at the shield and this eddy current raises the temperature of the shield. When the temperature of the shield rises, the heat generated at the shield may pass through the resin and raise the temperature of the power reception coil and the ferrite core. As a result, a rise in temperature of the power reception device is a concern.

[0007] In the case where the resin-sealed structure is used in a power transmission device as well, the problem similar to the problem described above may arise when a shield is arranged below the resin.

[0008] An object of the present invention is to provide a power reception device and a power transmission device including a structure that can suppress a rise in temperature of the power reception device and/or the power transmission device when a structure having a coil and a core unit sealed by a sealing member is used in the power reception device and/or the power transmission device, and to provide a vehicle including the power reception device.

Solution to Problem

[0009] A power reception device is a power reception device that receives electric power from a power transmission device having a power transmission coil in a contactless manner, with the power reception device facing the power transmission device, the power reception device including: a sealing member having a core unit and a power reception coil embedded therein; a shield arranged on an upper surface side of the sealing member with a spacing therebetween; and a heat insulating layer arranged between the shield and the upper surface of the sealing member, and having better heat insulation performance than that of the sealing member.

[0010] According to the aforementioned configuration, the heat insulating layer is provided between the sealing member and the shield. Therefore, even when a magnetic flux formed around the power reception coil during reception of the electric power passes through the shield and the temperature of the shield rises, the heat generated due to the rise in temperature of the shield is not directly transferred to the sealing member. As a result, it is possible to suppress a rise in temperature of the power reception coil and the core unit caused by the rise in temperature of the shield.

[0011] Preferably, the heat insulating layer is an air layer. Thus, it is possible to suppress a rise in temperature of the power reception coil and the core unit caused by the rise in temperature of the shield, without increasing the number of components.

[0012] Preferably, the shield is provided only on the upper surface side of the sealing member. With this configuration, the region of the shield is reduced in size and the

temperature rise region of the shield can be reduced in size.

- [0013] A vehicle includes: any one of the aforementioned power reception devices; and a vehicle main body having an exhaust pipe on a bottom surface thereof, wherein the power reception device is arranged below the exhaust pipe, and the shield is located between the exhaust pipe and the heat insulating layer. With this configuration, even when the radiant heat radiated from the exhaust pipe is transferred to the shield, heat transfer to the sealing member can be suppressed by the heat insulating layer.
- [0014] Preferably, the side surface of the sealing member is provided with a flange protruding laterally and having a bolt hole, and the power reception device is fixed to the vehicle main body by inserting a bolt through the bolt hole of the flange. Thus, the number of components can be reduced and the attachment work can be improved.
- [0015] A power transmission device is a power transmission device that transmits electric power to a power reception device having a power reception coil in a contactless manner, with the power transmission device facing the power reception device, the power transmission device including: a sealing member having a core unit and a power transmission coil embedded therein; a shield arranged on a lower surface side of the sealing member with a spacing therebetween; and a heat insulating layer arranged between the shield and the lower surface of the sealing member, and having better heat insulation performance than that of the sealing member.
- [0016] According to the aforementioned configuration, the heat insulating layer is provided between the sealing member and the shield. Therefore, even when a magnetic flux formed around the power transmission coil during transmission of the electric power passes through the shield and the temperature of the shield rises, the heat generated due to the rise in temperature of the shield is not directly transferred to the sealing member. As a result, it is possible to suppress a rise in temperature of the power transmission coil and the core unit caused by the rise in temperature of the shield.

Advantageous Effects of Invention

- [0017] According to the aforementioned configuration, there can be provided a power reception device and a power transmission device including a structure that can suppress a rise in temperature of the power reception device and/or the power transmission device when a structure having a coil and a core unit sealed by a sealing member is used in the power reception device and/or the power transmission device, and there can be provided a vehicle including the power reception device.

Brief Description of Drawings

- [0018] [fig.1]Fig. 1 is a diagram schematically showing a power transfer system in a first embodiment.
- [fig.2]Fig. 2 is a bottom view showing an electric powered vehicle in the first em-

bodiment.

[fig.3]Fig. 3 is a cross-sectional view taken along line III-III in Fig. 2.

[fig.4]Fig. 4 is a bottom view showing a power reception unit mounted on the electric powered vehicle in the first embodiment.

[fig.5]Fig. 5 is a cross-sectional view taken along line V-V in Fig. 4.

[fig.6]Fig. 6 is a perspective view showing a core unit of the power reception unit in the first embodiment.

[fig.7]Fig. 7 is a plan view showing a configuration of a power transmission unit in the first embodiment.

[fig.8]Fig. 8 is a cross-sectional view taken along line VIII-VIII in Fig. 7.

[fig.9]Fig. 9 is a cross-sectional view showing a configuration of a power reception unit in a second embodiment.

[fig.10]Fig. 10 is a cross-sectional view showing a configuration of a power transmission unit in the second embodiment.

Description of Embodiments

[0019] Each embodiment based on the present invention will be described hereinafter with reference to the drawings. When the number, an amount or the like is mentioned in the description of the embodiments, the scope of the present invention is not necessarily limited to that number, that amount or the like, unless otherwise specified. In the description of the embodiments and each example, the same and corresponding components are denoted by the same reference numerals, and redundant description will not be repeated.

First Embodiment

[0020] A power transfer system 1000 in a first embodiment will be described with reference to Fig. 1. Fig. 1 is a diagram schematically showing an overall configuration of power transfer system 1000. Power transfer system 1000 includes an electric powered vehicle 100 (vehicle) and an external power feeding device 300.

[0021] (Electric Powered Vehicle 100)

[0022] Referring to Fig. 1, electric powered vehicle 100 includes a vehicle main body 110 and a power reception device 200. Vehicle main body 110 is provided with a vehicle ECU 120 (control unit), a rectifier 130, a DC/DC converter (hereinafter simply referred to as "converter") 140, a battery 150, a power control unit (hereinafter simply referred to as "PCU") 160, a motor unit 170, a communication unit 180 and the like. Power reception device 200 has a power reception coil 250, which is arranged on a bottom surface of vehicle main body 110.

[0023] External power feeding device 300 includes a power transmission device 400, and power transmission device 400 has a power transmission coil 450. Power reception

device 200 receives electric power from power transmission device 400 in a contactless manner, with power reception coil 250 of power reception device 200 facing power transmission coil 450 of power transmission device 400.

[0024] Power reception device 200 has a power reception unit 210 and a capacitor 220 connected to power reception unit 210. Power reception unit 210 has a solenoid-type core unit 260 and power reception coil 250.

[0025] Power reception coil 250 has stray capacitance and is connected to rectifier 130. An induction coefficient of power reception coil 250 as well as the stray capacitance of power reception coil 250 and electric capacitance of capacitor 220 form an electrical circuit. Capacitor 220 and power reception coil 250 are connected serially, although they may be connected in parallel.

[0026] In power transfer system 1000, in the case where vehicle ECU 120 detects that a power feeding button has been turned on when vehicle main body 110 is in a stop state, the operation mode of the vehicle is switched to the charging mode. Through communication unit 180, vehicle ECU 120 instructs execution of charging control of battery 150 by external power feeding device 300.

[0027] (External Power Feeding Device 300)

[0028] External power feeding device 300 includes power transmission device 400, a high-frequency power device 310, a power transmission ECU 320, and a communication unit 322. High-frequency power device 310 is connected to an AC power supply 330. AC power supply 330 is a commercial power supply device, an independent power supply device or the like. Power transmission device 400 is provided within a parking space and connected to high-frequency power device 310. Power transmission ECU 320 controls driving of high-frequency power device 310 and the like.

[0029] Communication unit 322 is a communication interface for carrying out wireless communication between external power feeding device 300 and electric powered vehicle 100. Communication unit 322 receives the battery information, the signals for instructing start, continuation and stop of power transmission, the signal for instructing increase or decrease in transmitted electric power, and the like which are transmitted from communication unit 180 of electric powered vehicle 100, and outputs the information to power transmission ECU 320.

[0030] Power transmission device 400 has a power transmission unit 410 and a capacitor 420 connected to power transmission unit 410. Power transmission unit 410 has a solenoid-type core unit 440 and power transmission coil 450.

[0031] Power transmission coil 450 has stray capacitance and is connected to high-frequency power device 310. An induction coefficient of power transmission coil 450 as well as the stray capacitance of power transmission coil 450 and electric capacitance of capacitor 420 form an electrical circuit. Capacitor 420 and power transmission coil

450 are connected serially, although they may be connected in parallel.

[0032] High-frequency power device 310 converts electric power received from AC power supply 330 into high-frequency electric power, and supplies the converted high-frequency electric power to power transmission coil 450. Power transmission coil 450 transmits the electric power to power reception coil 250 of power reception unit 210 in a contactless manner by electromagnetic induction.

[0033] As described above, in power transmission device 400, high-frequency power device 310 converts the electric power received from AC power supply 330 into the high-frequency electric power, and supplies the converted high-frequency electric power to power transmission coil 450. Each of power transmission unit 410 and power reception unit 210 includes the coil (450, 250) and the capacitor (420, 220), and is designed to resonate at the transmission frequency. A Q value indicative of the resonance intensity of power transmission unit 410 and power reception unit 210 is preferably 100 or larger.

[0034] (Detailed Arrangement Position of Power Reception Unit 210)

[0035] A detailed arrangement position of power reception unit 210 will be described with reference to Figs. 2 and 3. Fig. 2 is a bottom view showing electric powered vehicle 100. Fig. 3 is a cross-sectional view taken along line III-III in Fig. 2. In Figs. 2 and 3, "D" represents a lower side D in the perpendicular direction. "L" represents a vehicle left direction L. "R" represents a vehicle right direction R. "F" represents a vehicle frontward-moving direction F. "B" represents a vehicle backward-moving direction B. "U" represents an upper side U in the perpendicular direction. These are common in below-described Figs. 5, 6 and 8 to 10 as well.

[0036] Referring to Fig. 2, vehicle main body 110 of electric powered vehicle 100 has a bottom surface 112. Bottom surface 112 refers to a visible region of vehicle main body 110 when vehicle main body 110 is viewed from a position that is distant from the ground in the direction of lower side D in the perpendicular direction, with wheels 111R, 111L, 118R, and 118L being in contact with the ground.

[0037] Bottom surface 112 has a center position P1. Center position P1 is located at the center of bottom surface 112 in the frontward-backward direction (vehicle frontward-moving direction F and vehicle backward-moving direction B) of vehicle main body 110, and is located at the center of bottom surface 112 in the vehicle width direction (vehicle left direction L and vehicle right direction R) of vehicle main body 110.

[0038] Bottom surface 112 is provided with a floor panel 114, side members 115R and 115L, an exhaust pipe 116, a not-shown cross member, and the like. Floor panel 114 has a plate-like shape and separates the inside of vehicle main body 110 from the outside of vehicle main body 110. Side members 115R and 115L and the cross member are arranged on a lower surface of floor panel 114.

- [0039] Vehicle main body 110 includes an engine 119, and this engine 119 is arranged more frontward (on the vehicle frontward-moving direction F side) than center position P1 in the frontward-backward direction. Exhaust pipe 116 is connected to engine 119 through a catalyst 117.
- [0040] Power reception unit 210 is provided on bottom surface 112 of vehicle main body 110. Power reception unit 210 is arranged more backward (on the vehicle backward-moving direction B side) than engine 119 in the frontward-backward direction, and more frontward (on the vehicle frontward-moving direction F side) than center position P1 in the frontward-backward direction.
- [0041] A coil winding axis O2 of power reception coil 250 of power reception unit 210 extends toward the direction parallel to the frontward-backward direction of vehicle main body 110. It is envisaged that coil winding axis O2 of power reception coil 250 becomes parallel to a coil winding axis of power transmission coil 450 (Fig. 1) when electric powered vehicle 100 is parked at a prescribed position in the parking space where power transfer is possible.
- [0042] As shown in Figs. 2 and 3, by using a flange 230F (four places) provided on a side portion of power reception unit 210, power reception unit 210 is fixed to floor panel 114 with a bolt B1. A nut N1 (or a tap) is preliminarily provided on floor panel 114. Flange 230F is provided integrally with a resin member 230 by insert molding.
- [0043] Exhaust pipe 116 is arranged within a center tunnel 114T of floor panel 114. Power reception unit 210 of power reception device 200 is arranged below exhaust pipe 116 so as to face exhaust pipe 116 with a spacing therebetween.
- [0044] (Detailed Structure of Power Reception Unit 210)
- [0045] A detailed structure of power reception unit 210 will be described with reference to Figs. 4 to 6. Fig. 4 is a bottom view showing power reception unit 210. Fig. 5 is a cross-sectional view taken along line V-V in Fig. 4. Fig. 6 is a perspective view showing the core unit.
- [0046] Power reception unit 210 includes power reception coil 250, core unit 260, resin member 230 in which core unit 260 and power reception coil 250 are embedded, and a shield 240 arranged on the upper surface side of resin member 230 with a spacing therebetween. Power reception coil 250 is spirally wound around a perimeter of core unit 260 including an upper surface and a lower surface of core unit 260, with coil winding axis O2 centered. A spacer 270 formed by a resin member or the like is arranged at each of four corners on the upper surface side of resin member 230.
- [0047] As described above, by using the resin-sealed structure in which core unit 260 and power reception coil 250 are embedded in resin member 230, the heat emitted from core unit 260 and power reception coil 250 can be released to the outside through the resin member. Furthermore, a bobbin used to position power reception coil 250 with

respect to core unit 260 becomes unnecessary.

- [0048] A copper plate, an aluminum plate or the like having a shielding function is used as shield 240. Spacer 270 is arranged at each of the four corners of the upper surface of resin member 230. A space between the upper surface of resin member 230 and shield 240, which is provided by spacers 270, constitutes a heat insulating layer 280 formed by an air layer having better heat insulation performance than that of resin member 230.
- [0049] The heat insulation performance herein means the performance of being difficult to transfer the heat. Having better heat insulation performance than that of resin member 230 means that it is more difficult to transfer the heat than resin member 230.
- [0050] Resin member 230 has a plate-like shape having a side surface, an upper surface and a lower surface, and has core unit 260 and power reception coil 250 embedded therein. Non-flammable polyester or the like is, for example, used as resin member 230.
- [0051] In Fig. 5, a total height (h) of power reception unit 210 is about 20 mm. A thickness of core unit 260 is about 9 mm, and a coil diameter of power reception coil 250 is about 3 mm, and a thickness of resin member 230 on the upper surface side and the lower surface side (covering thickness of the resin) is about 4 mm, and a plate thickness (t1) of shield 240 is about 0.5 mm. Therefore, in Fig. 5, a height h1 of resin member 230 is about 17 mm, and a thickness (h2) of heat insulating layer 280 is approximately 2.5 mm. In a planar view, a dimension excluding flanges 230F described below is approximately 240 mm x 290 mm. These dimensions are one example and the present invention is not limited thereto.
- [0052] At each of the four places of the side surface of resin member 230, flange 230F protruding laterally and having a bolt hole 231 is integrally molded by insert molding. Flange 230F may be integrally molded using the same material as resin member 230.
- [0053] (Core Unit 260)
- [0054] Fig. 6 is a perspective view showing core unit 260. Core unit 260 is formed by combining a plurality of divided cores 261 to 268, and these divided cores 261 to 268 are surrounded by an insulating paper 269. Ferrite is used for each of divided cores 261 to 268.
- [0055] Divided cores 261 to 268 are formed to be rectangular parallelepiped, and have the same shape and size. Divided cores 261 to 264 are arranged in four rows along the vehicle width direction (column direction) of vehicle main body 110, and divided cores 265 to 268 are also arranged in four rows along the vehicle width direction (column direction) of vehicle main body 110.
- [0056] Divided cores 261 to 264 and divided cores 265 to 268 are arranged in two rows along the vehicle frontward-backward direction, and divided cores 265 to 268 are arranged on the vehicle frontward-moving direction F side of divided cores 261 to 264

with a gap 290 of approximately 0.1 mm between divided cores 265 to 268 and divided cores 261 to 264. An adhesive is filled into this gap.

[0057] Core unit 260 has a plate-like shape as a whole, and an upper surface 260A is formed on upper side U in the perpendicular direction, and a lower surface 260B is formed on lower side D in the perpendicular direction. A side surface 260C is formed on the vehicle right direction R side, and a side surface 260D is formed on the vehicle backward-moving direction B side. A side surface 260E is formed on the vehicle left direction L side, and a side surface 260F is formed on the vehicle frontward-moving direction F side.

[0058] Outer surfaces of divided cores 261 to 264 and divided cores 265 to 268 are surrounded by insulating paper 269. A high heat transfer coefficient sheet (e.g., 0.18 mm in thickness) is, for example, used as insulating paper 269.

[0059] (Function and Effect)

[0060] Referring again to Fig. 3, in power reception unit 210 of power reception device 200 in the present embodiment, heat insulating layer 280 using air, which is inferior to resin member 230 in heat transfer property, is provided between resin member 230 and shield 240. Thus, even when the magnetic flux formed around power reception coil 250 during reception of the electric power passes through shield 240 and the temperature of shield 240 rises, the heat generated due to the rise in temperature of shield 240 is not directly transferred to resin member 230. As a result, it is possible to suppress a rise in temperature of power reception coil 250 and core unit 260 caused by the rise in temperature of shield 240.

[0061] Particularly, in the present embodiment, heat insulating layer 280 is an air layer formed by providing a spacing between the upper surface of resin member 230 and shield 240. Therefore, the external air can flow between resin member 230 and shield 240. Thus, arrival of the heat from shield 240 at resin member 230 is suppressed.

[0062] Furthermore, in power reception unit 210 in the present embodiment, shield 240 is provided only on the upper surface side of resin member 230. With such a configuration, the region of shield 240 is reduced in size and the temperature rise region of shield 240 can be reduced in size.

[0063] Furthermore, power reception unit 210 in the present embodiment is arranged below exhaust pipe 116 provided at vehicle main body 110, and shield 240 is located between exhaust pipe 116 and heat insulating layer 280. Thus, even when the radiant heat radiated from exhaust pipe 116 is transferred to shield 240, heat transfer to resin member 230 can be suppressed by heat insulating layer 280.

[0064] Furthermore, flange 230F protruding laterally and having bolt hole 231 is integrally molded on the side surface of the resin member in the present embodiment. Thus, power reception unit 210 can be fixed to vehicle main body 110 by inserting the bolt

through bolt hole 231 of flange 230F. As a result, the number of components can be reduced and the efficiency of the attachment work can be enhanced.

[0065] (Detailed Structure of Power Transmission Unit 410)

[0066] A detailed structure of power transmission unit 410 will be described with reference to Figs. 7 and 8. Fig. 7 is a plan view showing a configuration of power transmission unit 410. Fig. 8 is a cross-sectional view taken along line VIII-VIII in Fig. 7. The basic configuration of power transmission unit 410 in the present embodiment is the same as that of power reception unit 210 described above. A difference is that power transmission unit 410 is upside down.

[0067] By using a flange 430F (four places) provided on a side portion of power transmission unit 410, power transmission unit 410 is fixed to, for example, a floor surface with bolt B1. A nut or a tap is preliminarily provided on the floor surface. Flange 430F is provided integrally with a resin member 430 described below.

[0068] Power transmission unit 410 includes power transmission coil 450, a core unit 460, resin member 430 in which core unit 460 and power transmission coil 450 are embedded, and a shield 440 arranged on the lower surface side of resin member 430 with a spacing therebetween. Power transmission coil 450 is spirally wound around a perimeter of core unit 460 including an upper surface and a lower surface of core unit 460, with a coil winding axis (axis extending in parallel to coil winding axis O2 of power reception unit 210) centered. A spacer 470 formed by a resin member or the like is arranged at each of four corners on the lower surface side of resin member 430.

[0069] As described above, by using the resin-sealed structure in which core unit 460 and power transmission coil 450 are embedded in resin member 430, the heat emitted from core unit 460 and power transmission coil 450 can be released to the outside through the resin member. Furthermore, a bobbin used to position power transmission coil 450 with respect to core unit 460 becomes unnecessary.

[0070] A copper plate, an aluminum plate or the like having a shielding function is used as shield 440. Spacer 470 is arranged at each of the four corners of the lower surface of resin member 430. A space between the lower surface of resin member 430 and shield 440, which is provided by spacers 470, constitutes a heat insulating layer 480 formed by an air layer having better heat insulation performance than that of resin member 430.

[0071] Resin member 430 has a plate-like shape having a side surface, an upper surface and a lower surface, and has core unit 460 and power transmission coil 450 embedded therein. Non-flammable polyester or the like is, for example, used as resin member 430.

[0072] In Fig. 8, a total height (h) of power transmission unit 410 is about 20 mm. A thickness of core unit 460 is about 9 mm, and a coil diameter of power transmission

coil 450 is about 3 mm, and a thickness of resin member 430 on the upper surface side and the lower surface side (covering thickness of the resin) is about 4 mm, and a plate thickness (t_1) of shield 440 is about 0.5 mm. Therefore, in Fig. 8, a height h_1 of resin member 430 is about 17 mm, and a thickness (h_2) of heat insulating layer 480 is approximately 2.5 mm. In a planar view, a dimension excluding flanges 430F described below is approximately 240 mm x 290 mm. These dimensions are one example and the present invention is not limited thereto.

[0073] At each of the four places of the side surface of resin member 430, flange 430F protruding laterally and having a bolt hole 431 is integrally molded by insert molding. Flange 430F may be integrally molded using the same material as resin member 430.

[0074] Power transmission coil 450 is formed to be wound around an outer perimeter surface of core unit 460 to surround the coil winding axis (not shown). The coil winding axis extends toward the direction parallel to the frontward-backward direction of the parking space. The frontward-backward direction of the parking space refers to the direction corresponding to the frontward-backward direction of electric powered vehicle 100 when electric powered vehicle 100 stops at a prescribed position in the parking space where power transfer is possible.

[0075] For example, the coil winding axis extends toward the direction parallel to a parking line located on the right and left sides of the vehicle. For example, the coil winding axis extends toward the direction orthogonal to the arrangement direction of a wheel stopper located on the backward side of the vehicle (at the back in the parking space).

[0076] A configuration of core unit 460 is the same as that of core unit 260 used in power reception unit 210. Core unit 460 is formed by combining a plurality of divided cores 461 to 468, and these divided cores 461 to 468 are surrounded by an insulating paper 469.

[0077] (Function and Effect)

[0078] In power transmission unit 410 of power transmission device 400 in the present embodiment, heat insulating layer 480 using air, which is inferior to resin member 430 in heat transfer property, is provided between resin member 430 and shield 440. Thus, even when the magnetic flux formed around power transmission coil 450 during transmission of the electric power passes through shield 440 and the temperature of shield 440 rises, the heat generated due to the rise in temperature of shield 440 is not directly transferred to resin member 430. As a result, it is possible to suppress a rise in temperature of power transmission coil 450 and core unit 460 caused by the rise in temperature of shield 440.

[0079] Furthermore, in power transmission unit 410 in the present embodiment, shield 440 is provided only on the lower surface side of resin member 430. With such a configuration, the region of shield 440 is reduced in size and the temperature rise region of

shield 440 can be reduced in size.

- [0080] Furthermore, flange 430F protruding laterally and having bolt hole 431 is integrally molded on the side surface of the resin member in the present embodiment. Thus, power transmission unit 410 can be fixed to the floor surface by inserting the bolt through bolt hole 431 of flange 430F. As a result, the number of components can be reduced and the efficiency of the attachment work can be enhanced.

Second Embodiment

- [0081] A power reception unit 210A in a second embodiment will be described with reference to Fig. 9. Fig. 9 is a cross-sectional view showing a configuration of power reception unit 210A.
- [0082] The basic configuration of power reception unit 210A in the present embodiment is the same as that of power reception unit 210 in the first embodiment described above. A difference is that, instead of the air layer serving as heat insulating layer 280, a heat insulating member layer 280A is provided between shield 240 and the upper surface of resin member 230. A member having better heat insulation performance than that of resin member 230 is used in this heat insulating member layer 280A. It is conceivable to use, for example, a foamed resin as heat insulating member layer 280A.
- [0083] As described above, the function and effect similar to those of power reception unit 210 in the first embodiment can also be obtained in power reception unit 210A in which heat insulating member layer 280A is used instead of the air layer.
- [0084] Next, a power transmission unit 410A in the second embodiment will be described with reference to Fig. 10. Fig. 10 is a cross-sectional view showing a configuration of power transmission unit 410A.
- [0085] The basic configuration of power transmission unit 410A in the present embodiment is the same as that of power transmission unit 410 in the first embodiment described above. A difference is that, instead of the air layer serving as heat insulating layer 480, a heat insulating member layer 480A is provided between shield 440 and the lower surface of resin member 430. A member having better heat insulation performance than that of resin member 430 is used in this heat insulating member layer 480A. It is conceivable to use, for example, a foamed resin as heat insulating member layer 480A.
- [0086] As described above, the function and effect similar to those of power transmission device 400 in the first embodiment can also be obtained in power transmission unit 410A in which heat insulating member layer 480A is used instead of the air layer.

Other Embodiment

- [0087] In each of the aforementioned embodiments, the case of using the resin material such as non-flammable polyester as resin member 230, 430 has been described. However, the material is not limited to the resin material as long as it is a sealing member which

has a function equal to that of the resin material and which can have the core unit and the power reception/power transmission coil embedded therein. Therefore, a material having better heat insulation performance than that of sealing member 230, 430 is used in heat insulating layer 280, 480.

[0088] In each of the aforementioned embodiments, shields may also be provided on the side surface of resin member 230 of power reception unit 210 and on the side surface of resin member 430 of power transmission unit 410. However, according to the configurations of power reception unit 210, 210A and power transmission unit 410, 410A in each of the aforementioned embodiments, the distribution of the electromagnetic field leaking in the lateral direction is not significantly affected even if the shields are not provided on the side surfaces.

[0089] Therefore, as described in each of the aforementioned embodiments, in power reception unit 210, 210A, it is possible to use such a configuration that shield 240 is provided only on the upper surface side of resin member 230, and in power transmission unit 410, 410A, it is possible to use such a configuration that shield 440 is provided only on the lower surface side of resin member 430.

[0090] In each of the aforementioned embodiments, core unit 260, 460 is not limited to the configuration shown in Fig. 6. Core unit 260, 460 can be formed by a plurality of divided cores arranged side by side in a row direction and/or in a column direction. When the plurality of divided cores are used to form core unit 260, 460, the number of division in the extending direction of the coil winding axis ("two" in the present embodiment) is preferably smaller than the number of division in the direction orthogonal to the extending direction of the coil winding axis ("three" in the present embodiment), as shown in Fig. 6.

[0091] In each of the aforementioned embodiments, spacer 270, 470 is provided at each of the four corners of core unit 260, 460. However, arrangement of spacers 270, 470 is not limited thereto. A plurality of spacers 270, 470 may be provided at an edge portion of core unit 260, 460, or spacers 270, 470 may be annularly arranged at the edge portion of core unit 260, 460.

[0092] In each of the aforementioned embodiments, the case of fixing power reception unit 210, 210A of power reception device 200 to floor panel 114 has been described. However, the present invention is not limited to this fixing structure. For example, power reception unit 210, 210A may be suspended from side members 115R and 115L or the cross member.

[0093] In each of the aforementioned embodiments, the case of arranging power reception unit 210 of power reception device 200 below exhaust pipe 116 provided at vehicle main body 110. However, the present invention is not limited to such a configuration that power reception unit 210 is arranged below exhaust pipe 116.

[0094] In each of the aforementioned embodiments, the winding direction of the coil in power reception unit 210, 210A is not limited to around winding axis O2. For example, the winding direction of the winding axis may be a direction (R-L) orthogonal to winding axis O2. In this case, in power transmission unit 410, 410A as well, the winding direction of the winding axis is the same direction.

[0095] Although the embodiments have been described above, the embodiments disclosed herein are illustrative and not limitative in any respect. The technical scope of the present invention is defined by the terms of the claims, and is intended to include any modifications within the scope and meaning equivalent to the terms of the claims.

Reference Signs List

[0096] 100 electric powered vehicle; 110 vehicle main body; 111L, 111R, 118L, 118R wheel; 112 bottom surface; 114 floor panel; 115L, 115R side member; 116 exhaust pipe; 117 catalyst; 119 engine; 120 vehicle ECU; 130 rectifier; 140 DC/DC converter; 150 battery; 160 power control unit (PCU); 170 motor unit; 180, 322 communication unit; 200 power reception device; 210, 210A power reception unit; 220, 420 capacitor; 260, 460 core unit; 260A upper surface; 260B lower surface; 260C, 260D, 260E, 260F side surface; 261 to 268 divided core; 250 power reception coil; 290 gap; 300 external power feeding device; 310 high-frequency power device; 320 power transmission ECU; 330 AC power supply; 400 power transmission device; 410, 410A power transmission unit; 450 power transmission coil; 1000 power transfer system; O2 coil winding axis; P1 center position.

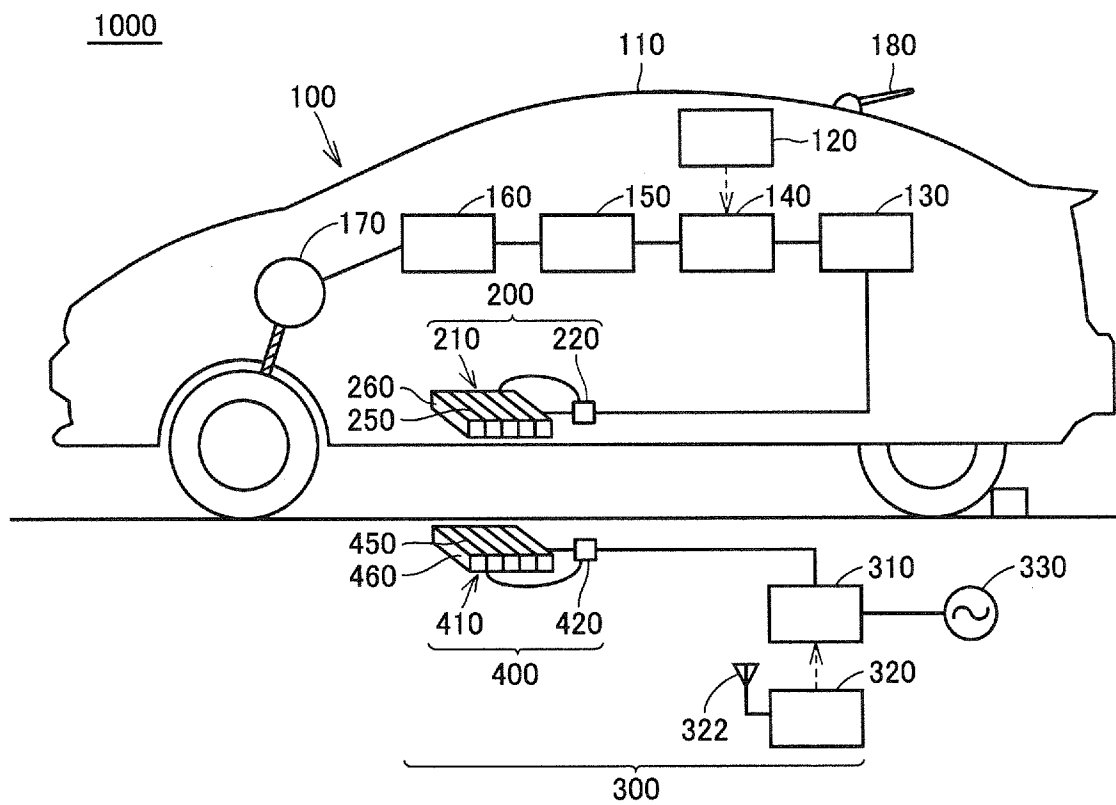
Claims

- [Claim 1] A power reception device comprising a power reception unit that receives electric power from a power transmission unit having a power transmission coil in a contactless manner, with said power reception unit facing said power transmission unit, said power reception unit including:
a core unit having a plate-like shape and including a side surface, an upper surface and a lower surface;
a power reception coil spirally wound around a perimeter of said core unit including said upper surface and said lower surface;
a sealing member having a plate-like shape having a side surface, an upper surface and a lower surface, and having said core unit and said power reception coil embedded therein;
a shield arranged on said upper surface side of said sealing member with a spacing therebetween; and
a heat insulating layer arranged between said shield and said upper surface of said sealing member, and having better heat insulation performance than that of said sealing member.
- [Claim 2] The power reception device according to claim 1, wherein said heat insulating layer is an air layer.
- [Claim 3] The power reception device according to claim 1 or 2, wherein said shield is provided only on said upper surface side of said sealing member.
- [Claim 4] A vehicle, comprising:
the power reception device as recited in any one of claims 1 to 3; and
a vehicle main body having an exhaust pipe on a bottom surface thereof, wherein
said power reception unit is arranged below said exhaust pipe, and
said shield is located between said exhaust pipe and said heat insulating layer.
- [Claim 5] The vehicle according to claim 4, wherein
said side surface of said sealing member is provided with a flange protruding laterally and having a bolt hole, and
said power reception unit is fixed to said vehicle main body by inserting a bolt through said bolt hole of said flange.
- [Claim 6] A power transmission device comprising a power transmission unit that transmits electric power to a power reception unit having a power

reception coil in a contactless manner, with said power transmission unit facing said power reception unit,
said power transmission unit including:
a core unit having a plate-like shape and including a side surface, an upper surface and a lower surface;
a power transmission coil spirally wound around a perimeter of said core unit including said upper surface and said lower surface;
a sealing member having a plate-like shape having a side surface, an upper surface and a lower surface, and having said core unit and said power transmission coil embedded therein;
a shield arranged on said lower surface side of said sealing member with a spacing therebetween; and
a heat insulating layer arranged between said shield and said lower surface of said sealing member, and having better heat insulation performance than that of said sealing member.

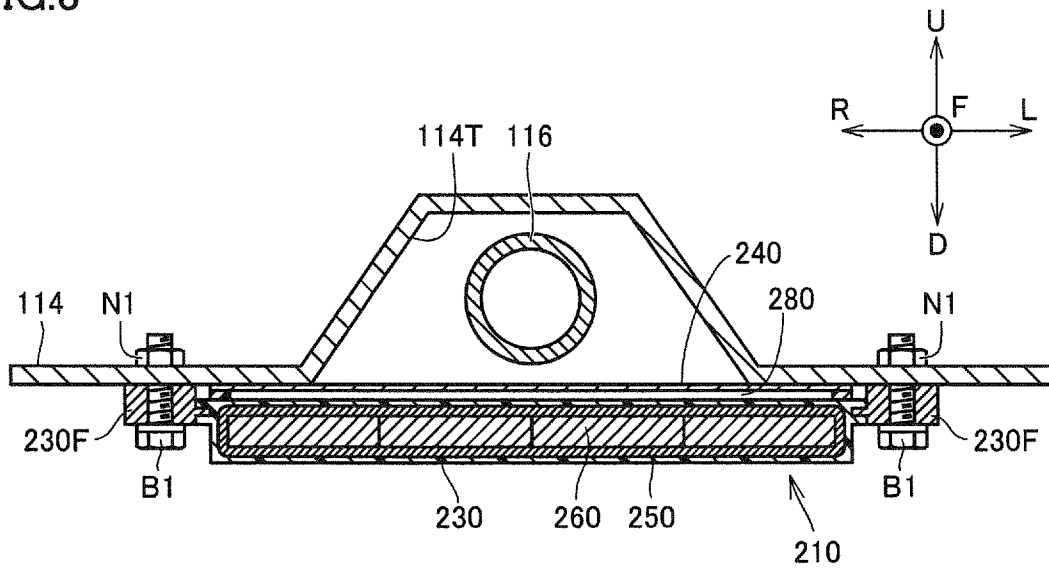
[Fig. 1]

FIG. 1



[Fig. 3]

FIG.3



[Fig. 4]

FIG.4

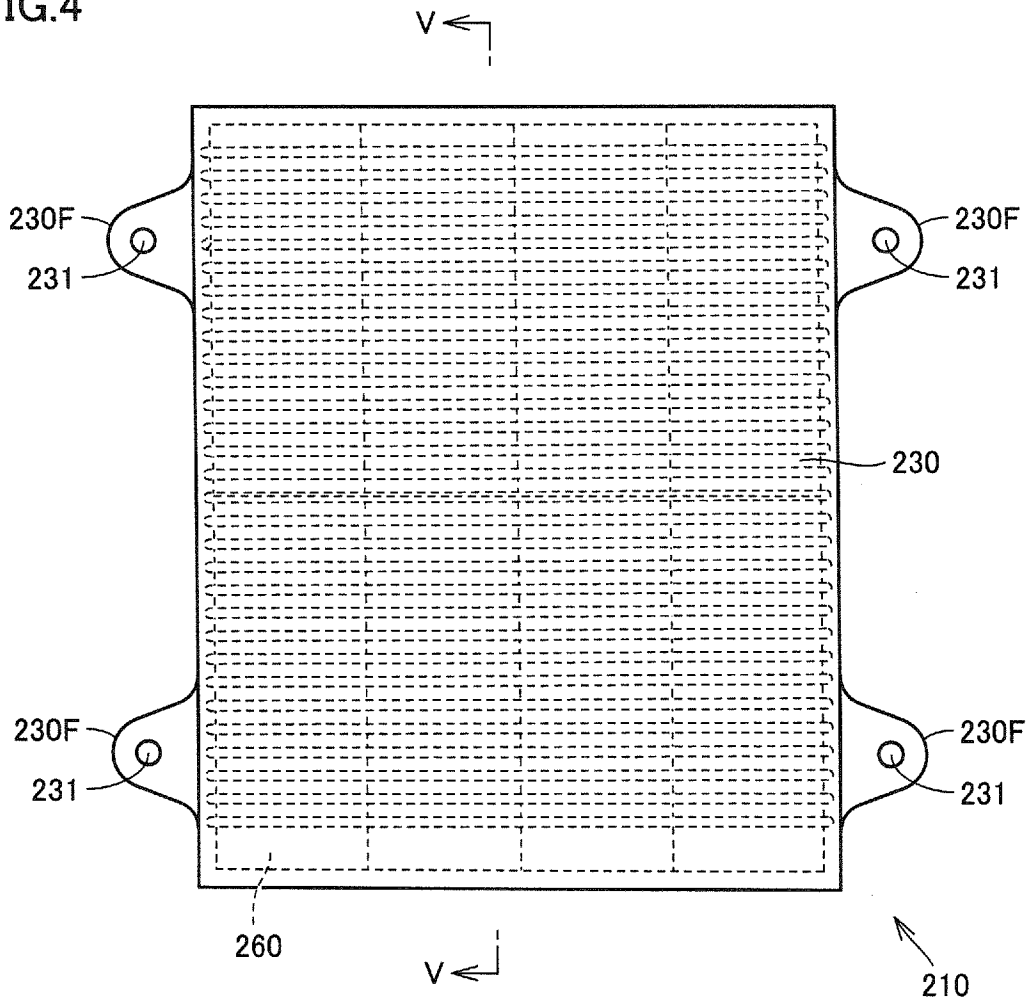
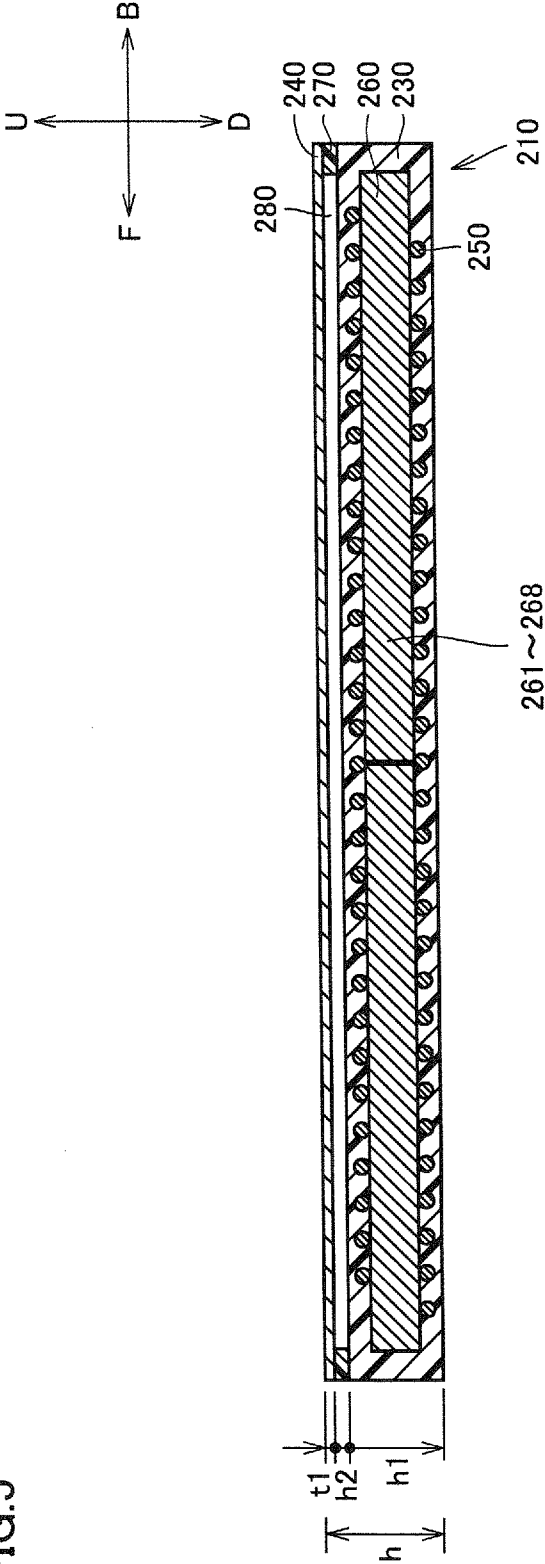


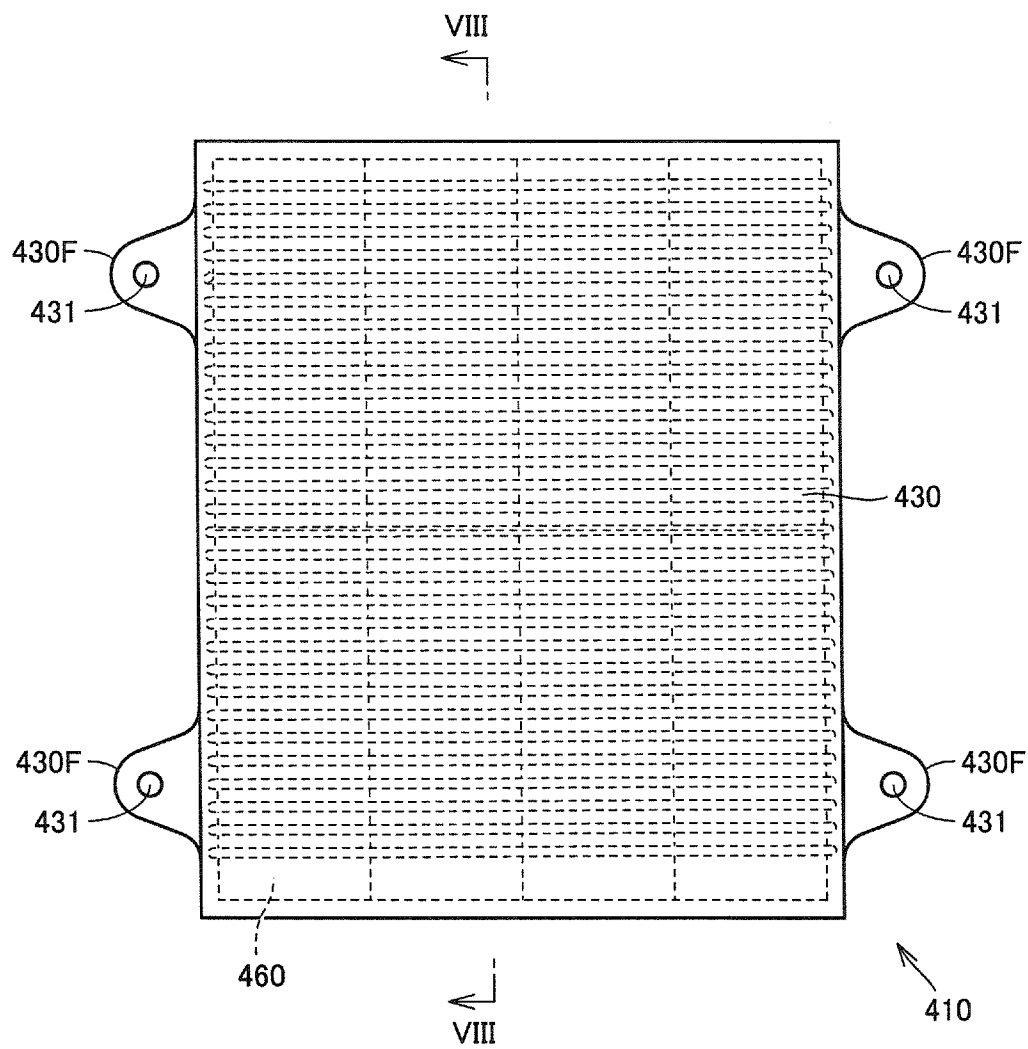
FIG.5

[Fig. 5]

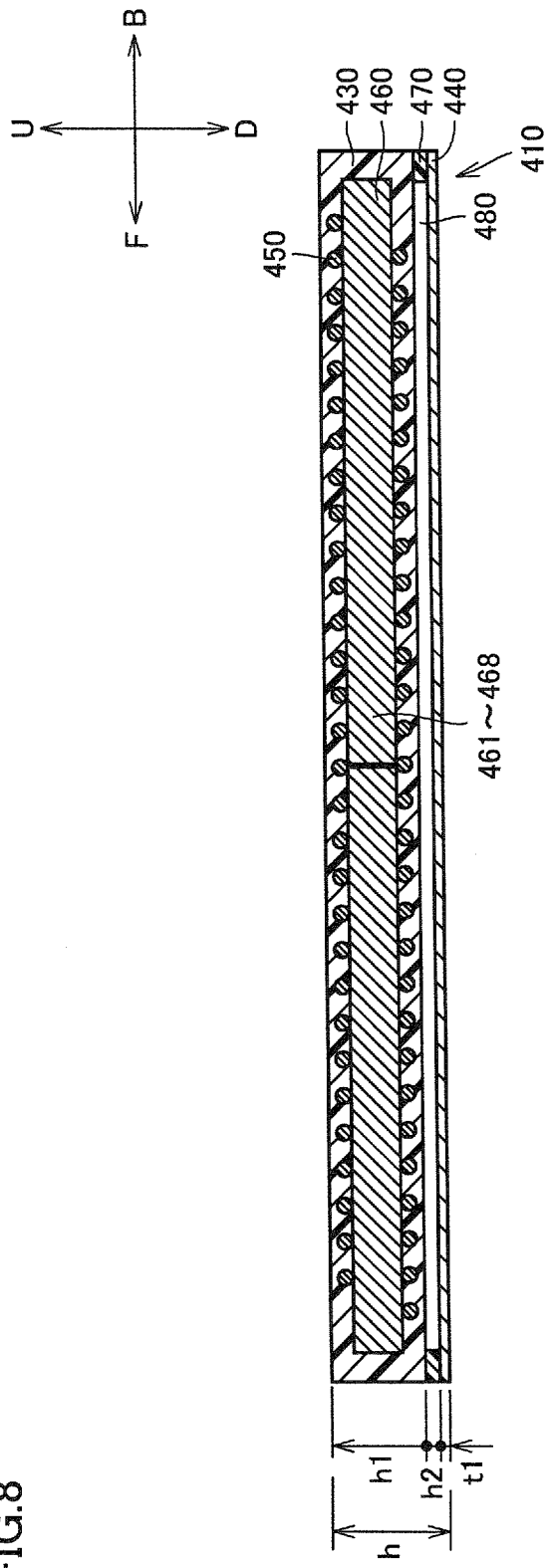


[Fig. 7]

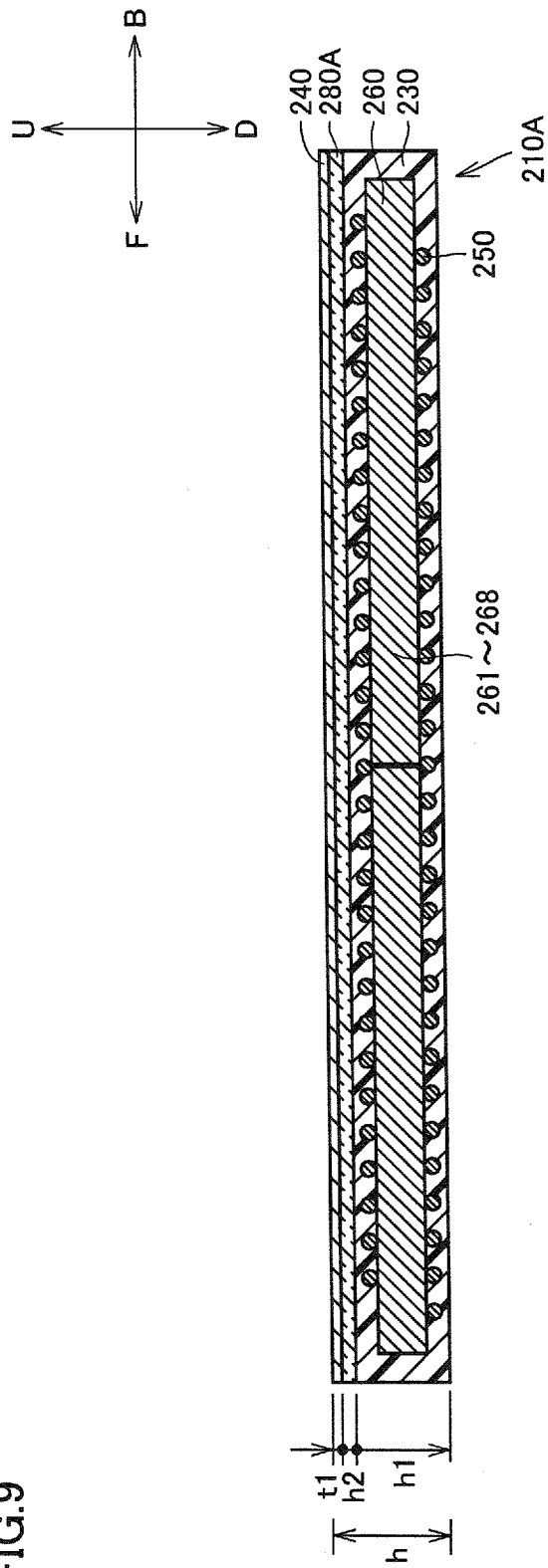
FIG. 7



[Fig. 8]



[Fig. 9]



[Fig. 10]

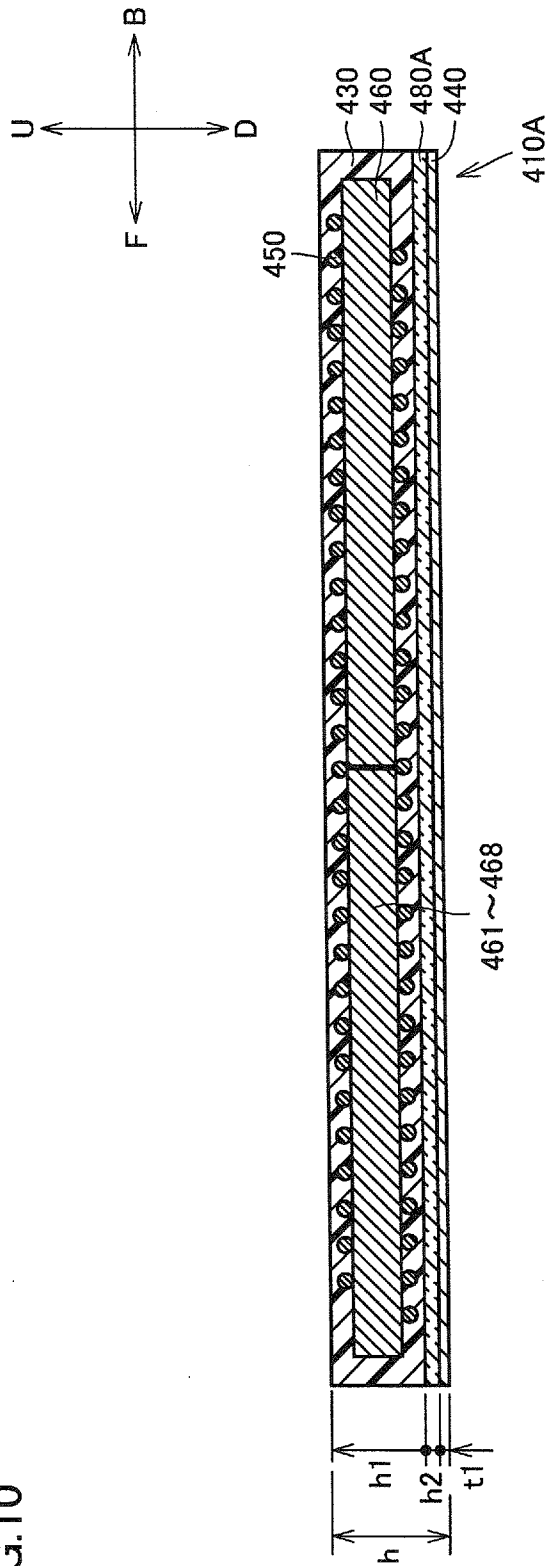


FIG.10

INTERNATIONAL SEARCH REPORT

International application No
PCT/JP2014/004024

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60L11/18
ADD.

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)
B60L H01F

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

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

EPO-Internal

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Y	paragraphs [0003], [0012], [0040], [0078], [0080], [0090], [0098] figures 1, 8, 9	4,5
Y	----- GB 2 497 822 A (AMPIUM LTD [GB]) 26 June 2013 (2013-06-26)	4,5
A	page 1, lines 5 - 10 page 2, lines 20 - 33 page 3, lines 12 - 16 page 5, lines 15 - 20, 25 - 30 page 7, lines 5 - 11 figure 1 ----- -/-	1-3,6



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

5 December 2014

Date of mailing of the international search report

12/12/2014

Name and mailing address of the ISA/

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Van den Berg, G

INTERNATIONAL SEARCH REPORT

International application No
PCT/JP2014/004024

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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