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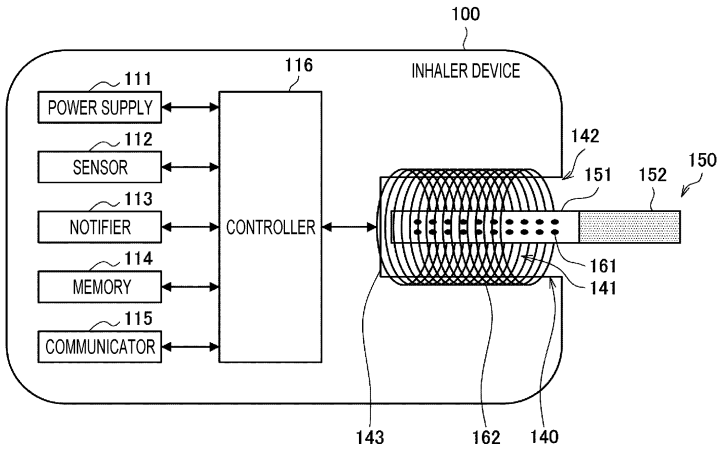
(54) SUCTION DEVICE, ELECTROMAGNETIC INDUCTION SOURCE, ELECTROMAGNETIC INDUCTION SOURCE MANUFACTURING METHOD, AND SYSTEM

(57) Provided is an electromagnetic induction source suitable for an induction heating type suction device. The present invention is a suction device provided with an electromagnetic induction source, said device comprising: a plurality of coil sheets 1 that are laminated; and at least one connecting portion. Each of the coil sheets has a substrate, a through hole penetrating through the substrate in the direction of lamination, and a conductor portion having a first end and a second end as the two ends and being disposed on the substrate so as to surround the through hole. The connecting portion electrically connects two coil sheets adjacent in the lamination direction, such that the second end of the conductor disposed on the coil sheet positioned above in the lamination direction and the first end of the conductor disposed on the coil sheet positioned below in the lamination direction are electrically connected.

FIG. 1



EP 4 233 594 A1

Description

Technical Field

[0001] The present invention relates to an inhaler device, an electromagnetic induction source, a manufacturing method for an electromagnetic induction source, and a system.

Background Art

[0002] An inhaler device that generates a substance to be inhaled by a user, such as an electronic tobacco and a nebulizer, is widely used. For example, an inhaler device uses a substrate including an aerosol source for generating an aerosol, a flavor source for imparting a flavor component to the generated aerosol, and the like, to generate an aerosol with the imparted flavor component. The user is able to taste a flavor by inhaling the aerosol with the imparted flavor component, generated by the inhaler device. An action that the user takes to inhale an aerosol is also referred to as puff or puff action below.

[0003] An inhaler device of a type using an external heat source, such as a heating blade, has been the mainstream so far. However, in recent years, an induction heating-type inhaler device that generates an aerosol by inductively heating a susceptor with an electromagnetic induction source configured as a coil, as described in Patent Literature 1 below, has become a focus of attention.

Citation List

Patent Literature

[0004] Patent Literature 1: JP 6623175 B2

Summary of Invention

Technical Problem

[0005] However, Patent Literature 1 describes that an existing coil is used as an electromagnetic induction source but does not describe improvement in the technology of an electromagnetic induction source itself at all.

[0006] The present invention is contemplated in view of the above problem, and it is an object of the present invention to provide a mechanism related to an electromagnetic induction source compatible with an induction heating-type inhaler device.

Solution to Problem

[0007] To solve the above problem, an aspect of the present invention provides an inhaler device. The inhaler device includes a power supply that supplies electric power, a container capable of accommodating a substrate containing an aerosol source and a susceptor in thermal proximity to the aerosol source in an internal space, and an electromagnetic induction source that generates a varying magnetic field in the internal space by using electric power supplied from the power supply. The electromagnetic induction source includes a plurality of coil sheets laminated, and one or more connecting portions. Each of the coil sheets has a board, a through-hole extending through the board in a lamination direction, and a conductor having a first end and a second end as both ends and disposed on or in the board so as to surround the through-hole. The connecting portion electrically connects the second end of the conductor disposed on or in the coil sheet located on an upper side in the lamination direction with the first end of the conductor disposed on or in the coil sheet located on a lower side in the lamination direction, of two of the coil sheets adjacent in the lamination direction. The first end of the conductor disposed on or in the coil sheet located on an uppermost side in the lamination direction and the second end of the conductor disposed on or in the coil sheet located on a lowermost side in the lamination direction are electrically connected to the power supply.

[0008] The plurality of coil sheets may be disposed such that the through-holes are lined up in the lamination direction.

[0009] The electromagnetic induction source may include one or more first seals. The first seal may seal a gap between two of the coil sheets adjacent in the lamination direction on a side closer to the through-holes than the conductors.

[0010] The electromagnetic induction source may include one or more second seals. The second seal may seal a gap between two of the coil sheets adjacent in the lamination direction on a side farther from the through-holes than the conductors.

[0011] The container may be disposed in a space formed by the plurality of through-holes lined up in the lamination direction.

[0012] The container may be made up of the plurality of through-holes lined up in the lamination direction and the one or more first seals.

[0013] The conductor may have a plurality of electrically conducting paths between the first end and the second end.

[0014] The plurality of electrically conducting paths may be disposed in parallel so as to be spaced apart from each other in a direction orthogonal to the lamination direction.

[0015] The first end may be exposed from the board to the upper side in the lamination direction, and the second end may be exposed from the board to the lower side in the lamination direction.

[0016] Two of the coil sheets adjacent in the lamination direction may be disposed such that the second end of the conductor disposed on or in the coil sheet located on the upper side in the lamination direction and the first end of the conductor disposed on or in the coil sheet located

on the lower side in the lamination direction substantially overlap each other in the lamination direction.

[0017] To solve the above problem, another aspect of the present invention provides an electromagnetic induction source that generates a varying magnetic field by using electric power supplied. The electromagnetic induction source includes a plurality of coil sheets laminated, and one or more connecting portions. Each of the coil sheets has a board, a through-hole extending through the board in a lamination direction, and a conductor having a first end and a second end as both ends and disposed on or in the board so as to surround the through-hole. The connecting portion electrically connects the second end of the conductor disposed on or in the coil sheet located on an upper side in the lamination direction with the first end of the conductor disposed on or in the coil sheet located on a lower side in the laminating direction, of two of the coil sheets adjacent in the lamination direction. The first end of the coil sheet located on an uppermost side in the lamination direction and the second end of the coil sheet located on a lowermost side in the lamination direction are electrically connected to a power supply that supplies electric power

[0018] To solve the above problem, another aspect of the present invention provides a manufacturing method for manufacturing an electromagnetic induction source that generates a varying magnetic field by using electric power supplied. The manufacturing method includes forming a plurality of coil sheets each of which includes a board, a through-hole extending through the board in a lamination direction, and a conductor having a first end and a second end as both ends and disposed on or in the board so as to surround the through-hole, laminating the plurality of coil sheets in the lamination direction, and electrically connecting the second end of the conductor disposed on or in the coil sheet located on an upper side in the lamination direction with the first end of the conductor disposed on or in the coil sheet located on a lower side in the lamination direction by a connecting portion, of two of the coil sheets adjacent in the lamination direction, for all combinations of two of the coil sheets adjacent in the lamination direction.

[0019] To solve the above problem, another aspect of the present invention provides a system. The system includes an inhaler device and a substrate. The substrate contains an aerosol source. The inhaler device includes a power supply that supplies electric power, a container capable of accommodating the substrate and a susceptor in thermal proximity to the aerosol source, and an electromagnetic induction source that generates a varying magnetic field in the internal space by using electric power supplied from the power supply. The electromagnetic induction source includes a plurality of coil sheets laminated, and one or more connecting portions. Each of the coil sheets has a board, a through-hole extending through the board in a lamination direction, and a conductor having a first end and a second end as both ends and disposed on or in the board so as to surround the through-hole. The connecting portion electrically connects the second end of the conductor disposed on or in the coil sheet located on an upper side in the lamination direction with the first end of the conductor disposed on or in the coil sheet located on a lower side in the lamination direction, of two of the coil sheets adjacent in the lamination direction. The first end of the conductor disposed on or in the coil sheet located on an uppermost side in the lamination direction and the second end of the conductor disposed on or in the coil sheet located on a lowermost side in the lamination direction are electrically connected to the power supply.

Advantageous Effects of Invention

[0020] As described above, according to the present invention, a mechanism related to an electromagnetic induction source compatible with an induction heating-type inhaler device is provided.

Brief Description of Drawings

[0021]

[FIG. 1] FIG. 1 is a schematic diagram that schematically illustrates a configuration example of an inhaler device.

[FIG. 2] FIG. 2 is a perspective view that schematically illustrates an example of the configuration of an electromagnetic induction source according to a present embodiment.

[FIG. 3] FIG. 3 is an exploded perspective view that schematically illustrates an example of the configuration of the electromagnetic induction source according to the present embodiment.

[FIG. 4] FIG. 4 is a top view that illustrates an example of the configuration of a coil sheet according to the present embodiment.

[FIG. 5] FIG. 5 is a sectional view that illustrates an example of a cross section of the electromagnetic induction source according to the present embodiment, taken along the line A-A in FIG. 2.

[FIG. 6] FIG. 6 is a sectional view that illustrates an example of a cross section of the electromagnetic induction source according to the present embodiment, taken along the line B-B in FIG. 2.

[FIG. 7] FIG. 7 is a flowchart that illustrates an example of the flow of a manufacturing method for manufacturing the electromagnetic induction source according to the present embodiment.

[FIG. 8] FIG. 8 is a sectional view that illustrates an example of a cross section of an electromagnetic induction source according to a first modification, taken along the line A-A in FIG. 2.

[FIG. 9] FIG. 9 is a sectional view that illustrates another example of a cross section of the electromagnetic induction source according to the first modification, taken along the line A-A in FIG. 2.

[FIG. 10] FIG. 10 is a top view that illustrates an example of the configuration of a coil sheet according to a second modification.

[FIG. 11] FIG. 11 is a top view that illustrates an example of two coil sheets adjacent in a lamination direction of a plurality of coil sheets included in an electromagnetic induction source according to a third modification.

[FIG. 12] FIG. 12 is a sectional view that illustrates part of a cross section of the electromagnetic induction source according to the third modification, taken along the line C-C in FIG. 11.

Description of Embodiments

[0022] Hereinafter, a preferred embodiment of the present invention will be described in detail with reference to the attached drawings. In the specification and the drawings, like reference signs denote structural elements having substantially the same functionalconfigurations, and the description will not be repeated.

< 1. Configuration Example of Inhaler Device>

[0023] An inhaler device according to the present configuration example generates an aerosol by heating a substrate containing an aerosol source by means of induction heating (IH). Hereinafter, the present configuration example will be described with reference to FIG. 1.

[0024] FIG. 1 is a schematic diagram that schematically illustrates a configuration example of an inhaler device. As illustrated in FIG. 1, an inhaler device 100 according to the present configuration example includes a power supply 111, a sensor 112, a notifier 113, a memory 114, a communicator 115, a controller 116, a susceptor 161, an electromagnetic induction source 162, and a holder 140. A user inhales in a state where a stick substrate 150 is held by the holder 140. Hereinafter, structural elements will be sequentially described.

[0025] The power supply 111 stores electric power. The power supply 111 supplies electric power to the structural elements of the inhaler device 100. The power supply 111 can be a rechargeable battery, such as a lithium ion secondary battery. The power supply 111 may be charged when connected to an external power supply with a universal serial bus (USB) cable or the like. Alternatively, the power supply 111 may be charged with a wireless power transmission technology in a state not connected to a power transmitting device. Other than the above, only the power supply 111 may be allowed to be removed from the inhaler device 100 or may be allowed to be replaced with a new power supply 111.

[0026] The sensor 112 detects various items of information regarding the inhaler device 100. The sensor 112 outputs the detected information to the controller 116. In an example, the sensor 112 is a pressure sensor, such as a capacitor microphone, a flow sensor, or a temperature sensor. When the sensor 112 detects a numeric value resulting from user's inhalation, the sensor 112 outputs, to the controller 116, information indicating that the user has inhaled In another example, the sensor 112 is an input device that receives information input by the user, such as a button and a switch. Particularly, the sensor 112 can include a button for instructions to start or stop generating an aerosol. The sensor 112 outputs, to the controller 116, information input by the user. In another example, the sensor 112 is a temperature sensor that detects the temperature of the susceptor 161. The temperature sensor, for example, detects the temperature of the susceptor 161 in accordance with an electric resistance value of the electromagnetic induction source 162. The sensor 112 may detect the temperature of the stick substrate 150 held by the holder 140 in accordance with the temperature of the susceptors 161.

[0027] The notifier 113 notifies the user of information. In an example, the notifier 113 is a light-emitting device, such as a light emitting diode (LED). In this case, the notifier 113 emits light in a different pattern of light, for example, when the state of the power supply 111 is a charging required state, when the power supply 111 is in being charged, or when there is an abnormality in the inhaler device 100. The pattern of light here is a concept including color, the timing to turn on or off, and the like. The notifier 113 may be a display device that displays an image, a sound output device that outputs sound, or a vibration device that vibrates, in addition to or instead of the light-emitting device. Other than the above, the notifier 113 may notify information indicating that the user is allowed to inhale. The information indicating that the user is allowed to inhale is notified when the temperature of the stick substrate 150 heated by electromagnetic induction reaches a predetermined temperature.

[0028] The memory 114 stores various items of information for the operation of the inhaler device 100. The memory 114 is, for example, a non-volatile storage medium, such as a flash memory. An example of the pieces of information stored in the memory 114 is information regarding an operating system (OS) of the inhaler device 100, such as the content of control over various structural elements by the controller 116. Another example of the items of information stored in the memory 114 is information regarding user's inhalation, such as the number of times of inhalation, inhalation time, and an accumulated inhalation time period.

[0029] The communicator 115 is a communication interface for transmitting and receiving information between the inhaler device 100 and another device. The communicator 115 performs communication that conforms with any wired or wireless communication standard. A wireless local area network (LAN), a wired LAN, Wi-Fi (registered trademark), Bluetooth (registered trademark), or the like can be adopted as such a communication standard. In an example, the communicator 115 transmits information regarding user's inhalation to a smartphone in order to display the information regarding user's inhalation on the smartphone. In another ex-

ample, the communicator 115 receives new information on the OS from a server in order to update the information on the OS, stored in the memory 114.

[0030] The controller 116 functions as an arithmetic processing unit and a control unit and controls the overall operations in the inhaler device 100 in accordance with various programs. The controller 116 includes an electronic circuit, such as a central processing unit (CPU) and a microprocessor. The controller 116 may further include a read only memory (ROM) that stores programs and arithmetic parameters to be used, and a random access memory (RAM) that temporarily stores variable parameters as needed. The inhaler device 100 executes various pieces of processing in accordance with control by the controller 116. Feeding of electric power from the power supply 111 to another structural element, charging of the power supply 111, detection of information by the sensor 112, notification of information by the notifier 113, storing and reading of information by the memory 114, and transmitting and receiving of information by the communicator 115 each are an example of the pieces of processing to be controlled by the controller 116. Other pieces of processing to be executed by the inhaler device 100, such as input of information to each structural element and processing based on information output from each structural element, are controlled by the controller 116.

[0031] The holder 140 has an internal space 141. The holder 140 holds the stick substrate 150 while accommodating part of the stick substrate 150 in the internal space 141. The holder 140 has an opening 142 that allows the internal space 141 to communicate with outside. The holder 140 holds the stick substrate 150 that is inserted into the internal space 141 through the opening 142. For example, the holder 140 is a tubular body having the opening 142 and a bottom 143 at the ends, and defines the columnar internal space 141. The holder 140 can be formed such that the inside diameter is smaller than the outside diameter of the stick substrate 150 in at least part of the tubular body in the height direction of the tubular body. The holder 140 can hold the stick substrate 150 such that the stick substrate 150 inserted in the internal space 141 is pressed from the outer circumference. The holder 140 also has the function to define a flow path for air passing through the stick substrate 150. An air inlet hole that is an inlet for air into the flow path is disposed at, for example, the bottom 143. On the other hand, an air outlet hole that is an outlet for air from the flow path is the opening 142.

[0032] The stick substrate 150 is a stick member. The stick substrate 150 includes a substrate 151 and an inhalation port 152.

[0033] The substrate 151 includes an aerosol source. When the aerosol source is heated, the aerosol source is atomized to generate an aerosol. The aerosol source may be, for example, a substance derived from tobacco, such as a processed substance obtained by forming shredded tobacco or tobacco raw material into a granular form, a sheet form, or a powder form. The aerosol source may contain a substance not derived from tobacco and made from a plant other than tobacco (for example, mint, a herb, or the like). In an example, the aerosol source may contain a flavor component, such as menthol. When the inhaler device 100 is a medical inhaler, the aerosol source may contain a medicine for a patient to inhale. The aerosol source is not limited to a solid and may be, for example, a liquid, such as polyhydric alcohol and water. Examples of the polyhydric alcohol include glycerine and propylene glycol. At least part of the substrate 151 is accommodated in the internal space 141 of the holder 140 in a state where the stick substrate 150 is held by the holder 140.

[0034] The inhalation port 152 is a member to be held in a mouth of the user during inhalation. At least part of the inhalation port 152 protrudes from the opening 142 in a state where the stick substrate 150 is held by the holder 140. When the user inhales with the inhalation port 152 protruding from the opening 142 in his or her mouth, air flows into the holder 140 through the air inlet hole (not illustrated). Air flowing in passes through the internal space 141 of the holder 140, that is, passes through the substrate 151, and reaches the inside of the mouth of the user together with an aerosol that is generated from the substrate 151.

[0035] The stick substrate 150 further includes the susceptor 161. The susceptor 161 produces heat by electromagnetic induction. The susceptor 161 is made of a conductive raw material, such as a metal. In an example, the susceptor 161 is pieces of metal. The susceptor 161 is disposed in proximity to the aerosol source. In the example illustrated in FIG. 1, the susceptor 161 is included in the substrate 151 of the stick substrate 150.

[0036] Here, the susceptor 161 is disposed in thermal proximity to the aerosol source. The state where the susceptor 161 is in thermal proximity to the aerosol source means that the susceptor 161 is disposed at a position where heat generated at the susceptor 161 is transferred to the aerosol source. For example, the susceptor 161 is included in the substrate 151 together with the aerosol source and surrounded by the aerosol source. With this configuration, heat generated from the susceptor 161 can be efficiently used to heat the aerosol source.

[0037] The susceptor 161 may be untouchable from outside of the stick substrate 150. For example, the susceptor 161 may be distributed in a central part of the stick substrate 150 but does not need to be distributed near the outer circumference of the stick substrate 150.

[0038] The electromagnetic induction source 162 causes the susceptor 161 to produce heat by electromagnetic induction. The electromagnetic induction source 162 is, for example, a coiled conductive wire wound around the outer circumference of the holder 140. When the electromagnetic induction source 162 is supplied with alternating current from the power supply 111, the electromagnetic induction source 162 generates a magnetic field. The electromagnetic induction source

162 is disposed at a position where the internal space 141 of the holder 140 overlaps the generated magnetic field. Thus, when the magnetic field is generated in a state where the stick substrate 150 is held by the holder 140, eddy current is generated in the susceptor 161, and Joule heat is generated. Subsequently, the aerosol source included in the stick substrate 150 is heated and atomized by the Joule heat to generate an aerosol. In an example, when the sensor 112 detects that predetermined user input is performed, electric power may be supplied to generate an aerosol. When the temperature of the stick substrate 150 inductively heated by the susceptor 161 and the electromagnetic induction source 162 reaches a predetermined temperature, the user is allowed to inhale. After that, when the sensor 112 detects that the predetermined user input is performed, supply of electric power may be stopped. In another example, in a period during which the sensor 112 detects that the user has inhaled, electric power may be supplied to generate an aerosol.

[0039] FIG. 1 shows an example in which the susceptor 161 is included in the substrate 151 of the stick substrate 150; however, the present configuration example is not limited to this example. For example, the holder 140 may have the function of the susceptor 161. In this case, eddy current is generated in the holder 140 by the magnetic field generated by the electromagnetic induction source 162, and Joule heat is generated. Subsequently, the aerosol source included in the stick substrate 150 is heated and atomized by the Joule heat to generate an aerosol.

[0040] In terms of the point that an aerosol can be generated by combining the inhaler device 100 with the stick substrate 150, a combination of the inhaler device 100 with the stick substrate 150 may be regarded as one system.

<2. Induction Heating>

[0041] Induction heating will be described in detail below.

[0042] Induction heating is a process of causing a varying magnetic field to enter a conductive physical object to heat the physical object. A magnetic field generator that generates a varying magnetic field and a conductive heated object that is heated when exposed to a varying magnetic field relate to induction heating. An example of the varying magnetic field is an alternating magnetic field. The electromagnetic induction source 162 illustrated in FIG. 1 is an example of the magnetic field generator. The susceptor 161 illustrated in FIG. 1 is an example of the heated object.

[0043] When a varying magnetic field is generated from the magnetic field generator in a state where the magnetic field generator and the heated object are disposed in a relative position such that the varying magnetic field generated from the magnetic field generator enters the heated object, eddy current is induced in the heated object. When the eddy current flows through the heated object, Joule heat according to the electrical resistance of the heated object is generated to heat the heated object. Such heating is also referred to as Joule heating, ohmic heating, or resistance heating.

[0044] The heated object may have magnetism. In this case, the heated object is further heated by magnetic hysteresis heating. Magnetic hysteresis heating is a process of causing a varying magnetic field to enter a magnetic object to heat the object. When a magnetic field enters a magnetic substance, magnetic dipoles contained in the magnetic substance are aligned along the magnetic field. Therefore, when a varying magnetic field enters a magnetic substance, the orientations of the magnetic dipoles change with the varying magnetic field applied. With such reorientation of the magnetic dipoles, heat is generated in the magnetic substance, and the heated object is heated.

[0045] Magnetic hysteresis heating typically occurs at a temperature lower than or equal to a Curie point and does not occur at a temperature exceeding the Curie point. A Curie point is a temperature at which a magnetic substance loses its magnetic properties. For example, when the temperature of a heated object having a ferromagnetism at a temperature lower than or equal to a Curie point exceeds the Curie point, a reversible phase transition from ferromagnetism to paramagnetism occurs in the magnetism of the heated object. When the temperature of the heated object exceeds the Curie point, magnetic hysteresis heating does not occur any more, so the rate of increase in temperature reduces.

[0046] The heated object is desirably made of a conductive material. The heated object is further desirably made of a material having ferromagnetism. This is because, in the latter case, heating efficiency can be increased by a combination of resistance heating and magnetic hysteresis heating. For example, the heated object is made of one or more raw materials selected from a raw material group consisting of aluminum, iron, nickel, cobalt, conductive carbon, copper, stainless steel, and the like.

[0047] In both resistance heating and magnetic hysteresis heating, heat is not generated by heat conduction from an external heat source but generated in the heated object. Therefore, a steep increase in temperature and a uniform heat distribution in the heated object can be implemented. This can be implemented by appropriately designing the material and shape of the heated object and the magnitude and orientation of the varying magnetic field. In other words, a steep increase in temperature and a uniform heat distribution in the stick substrate 150 can be implemented by appropriately designing the distribution of the susceptor 161 included in the stick substrate 150. Therefore, it is possible to shorten time for preheating, and it is also possible to improve the quality of a flavor tasted by the user.

[0048] Since induction heating directly heats the susceptor 161 included in the stick substrate 150, it is possible to efficiently heat the substrate as compared to

when the stick substrate 150 is heated from the outer circumference or the like with an external heat source. When heating using an external heat source is performed, the external heat source is inevitably higher in temperature than the stick substrate 150. On the other hand, when induction heating is performed, the electromagnetic induction source 162 does not become higher in temperature than the stick substrate 150. Therefore, the temperature of the inhaler device 100 can be maintained at low temperatures as compared to when an external heat source is used, so it is a great benefit in relation to user's safety.

[0049] The electromagnetic induction source 162 generates a varying magnetic field by using electric power supplied from the power supply 111. In an example, the power supply 111 may be a direct current (DC) power supply. In this case, the power supply 111 supplies alternating-current power to the electromagnetic induction source 162 via a DC/AC (alternate current) inverter In this case, the electromagnetic induction source 162 can generate an alternating magnetic field.

[0050] The holder 140 is an example of a container capable of accommodating the stick substrate 150 and the susceptor 161 in the internal space 141. The electromagnetic induction source 162 generates a varying magnetic field in the internal space 141 by using electric power supplied from the power supply 111. The susceptor 161 produces heat when a varying magnetic field enters the susceptor 161. The electromagnetic induction source 162 illustrated in FIG. 1 is a solenoid-type coil. The solenoid-type coil is disposed such that a conductive wire covers the outer circumference of the holder 140. When current is applied to the solenoid-type coil, a magnetic field is generated in a central space surrounded by the coil, that is, the internal space 141 of the holder 140. As illustrated in FIG. 1, in a state where the stick substrate 150 is held by the holder 140, the susceptor 161 is surrounded by the coil. Therefore, the varying magnetic field generated from the electromagnetic induction source 162 enters the susceptor 161 to inductively heat the susceptor 161.

<3. Technical Features>

[0051] A coil that is an electromagnetic induction source can be a bottleneck for reducing the size of an induction heating-type inhaler device. This is because the coil increases in length in a winding shaft direction and, as a result, the coil occupies a not small area of an inhaler device. On the other hand, it is presumably possible to reduce the size of the coil by shortening a conductive wire that is a coil. However, if the length of a conductive wire is shortened, it may be difficult to generate a sufficiently strong magnetic field for inductively heating a susceptor because the number of turns of the coil cannot be ensured.

[0052] A method of manufacturing a coil by winding a conductive wire around a cylindrical winding shaft presumably has a limit from various viewpoints, such as size reduction and precision.

[0053] The present embodiment provides a mechanism of making the electromagnetic induction source 162 by laminating boards each provided with an annular conductive wire track.

(1) Configuration of Electromagnetic Induction Source 162

[0054] Hereinafter, the configuration of the electromagnetic induction source 162 according to the present embodiment will be described with reference to FIGS. 2 to 6.

[0055] FIG. 2 is a perspective view that schematically illustrates an example of the configuration of the electromagnetic induction source 162 according to the present embodiment. FIG. 3 is an exploded perspective view that schematically illustrates an example of the configuration of the electromagnetic induction source 162 according to the present embodiment. FIG. 4 is a top view that illustrates an example of the configuration of a coil sheet 10 according to the present embodiment. FIG. 5 is a sectional view that illustrates an example of a cross section of the electromagnetic induction source 162 according to the present embodiment, taken along the line A-A in FIG. 2. FIG. 6 is a sectional view that illustrates an example of a cross section of the electromagnetic induction source 162 according to the present embodiment, taken along the line B-B in FIG. 2.

[0056] As illustrated in FIGS. 2 and 3, the electromagnetic induction source 162 includes a plurality of the coil sheets 10 laminated and one or more connecting portions 50. In the example illustrated in FIGS. 2 and 3, the electromagnetic induction source 162 includes four coil sheets 10 (10A to 10D) and three connecting portions 50 (50A to 50C). Of course, the number of the coil sheets 10 and the number of the conductors 40 are not limited to this example. The lamination direction is a direction in which the coil sheets 10 are laminated. In the lamination direction, one side is also referred to as upper side, and the other side is also referred to as lower side. In the specification, it is assumed that the electromagnetic induction source 162 is assembled to the inhaler device 100 such that the upper side in the lamination direction is a side closer to the opening 142 and the lower side in the lamination direction is a side farther from the opening 142.

[0057] In the specification and the drawings, elements each having substantially the same functional configuration can be distinguished from one another by suffixing different alphabets to the same reference signs. For example, a plurality of elements each having substantially the same functional configuration is distinguished from one another like coil sheets 10A, 10B, 10C where necessary. However, when a plurality of elements each having substantially the same functional configuration does not need to be distinguished from one another, only the

same reference sign is assigned. When, for example, the coil sheets 10A, 10B, 10C do not need to be distinguished from one another, the coil sheets 10A, 10B, 10C are simply referred to as coil sheets 10.

[0058] As illustrated in FIG. 4, the coil sheet 10 has a board 20, a through-hole 30 extending through the board 20 in the lamination direction, and the conductor 40.

[0059] The board 20 is a sheet-shaped member. For example, the board 20 is made of a flexible material having electrical insulation properties. The board 20 is formed in any shape according to the shape of a housing that is a re-outer casing of the inhaler device 100, the shape of a component to be stored around the electromagnetic induction source 162, and the like. In other words, the board 20 is not limited to a square shape illustrated in FIG. 4 and can be any shape, such as a circular shape. The shape of each of the plurality of boards 20 laminated may be different from each other.

[0060] The conductor 40 is made of any conductor, such as copper. The conductor 40 may be formed by applying conductive ink on the board 20 and curing the conductive ink. Examples of the conductive ink include ink containing any conductive substance, such as silver nanoparticles. Other than the above, the conductor 40 may be formed by using a method, such as vapor deposition and sputtering. The conductor 40 has a first end 41 and a second end 42 as both ends. The conductor 40 is disposed on the board 20 so as to surround the through-hole 30. In the example illustrated in FIG. 4, the conductor 40 has an annular electrically conducting path 43 with one intermittent part.

[0061] The connecting portion 50 is disposed between two coil sheets 10 adjacent in the lamination direction. The connecting portion 50 electrically connects the second end 42 of the conductor 40 disposed on the coil sheet 10 located on the upper side in the lamination direction with the first end 41 of the conductor 40 disposed on the coil sheet 10 located on the lower side in the lamination direction, of two of the coil sheets 10 adjacent in the lamination direction. The connecting portion 50 is made of any conductor, such as copper. In the example illustrated in FIG. 3, the connecting portion 50A connects the second end 42A of the conductor 40A disposed on the coil sheet 10A with the first end 41B of the conductor 40B disposed on the coil sheet 10B. The connecting portion 50B connects the second end 42B of the conductor 40B disposed on the coil sheet 10B with the first end 41C of the conductor 40C disposed on the coil sheet 10C. The connecting portion 50C connects the second end 42C of the conductor 40C disposed on the coil sheet 10C with the first end 41D of the conductor 40D disposed on the coil sheet 10D. With this configuration, the plurality of annular electrically conducting paths 43 respectively provided in the plurality of laminated coil sheets 10 can be connected to each other by the connecting portion 50 at the intermittent part to form a single coil.

[0062] The first end 41 of the conductor 40 disposed on the coil sheet 10 located on the uppermost side in the lamination direction and the second end 42 of the conductor 40 disposed on the coil sheet 10 located on the lowermost side in the lamination direction are electrically connected to the power supply 111. In the example illustrated in FIGS. 2 and 3, the first end 41A of the conductor 40A disposed on the coil sheet 10A and a second the second end 42B of the conductor 40D disposed on the coil sheet 10D are electrically connected to the power supply 111. With this configuration, the electromagnetic induction source 162 can generate a varying magnetic field by using alternating-current power supplied from the power supply 111.

[0063] A board with no conductor 40 may be disposed on a further upper side of the coil sheet 10 located on the uppermost side in the lamination direction. In this case, the conductor 40 provided in the coil sheet 10 located on the uppermost side in the lamination direction can be protected by being covered with the board.

[0064] As shown in FIG. 3, the plurality of coil sheets 10 is disposed such that the through-holes 30 are lined up in the lamination direction. In other words, in a state where the plurality of coil sheets 10 is laminated, the through-holes 30 respectively formed in the coil sheets 10 are disposed so as to be lined up with one another in plan view. With this configuration, it is possible to form a space 31 surrounded by the laminated through-holes 30. In a state where the electromagnetic induction source 162 is assembled to the inhaler device 100, the stick substrate 150 is inserted in the space 31 formed by the laminated through-holes 30 as illustrated in FIG. 2.

[0065] The holder 140 may be disposed in the space 31 formed by the plurality of through-holes 30 lined up in the lamination direction. For example, the holder 140 formed in a cylindrical shape is disposed so as to be fitted to the space 31 formed in a cylindrical shape. In this case, the stick substrate 150 is inserted into the holder 140 from the upper side toward the lower side in the lamination direction. On the other hand, the stick substrate 150 is removed from the holder 140 from the lower side toward the upper side in the lamination direction.

[0066] The shape of each through-hole 30 is typically a circular shape illustrated in FIG. 3. Alternatively, the shape of each through-hole 30 may be selectively formed according to the outer shape of the holder 140 disposed in the space 31.

[0067] As illustrated in FIG. 6, the first end 41 is exposed from the board 20 to the upper side in the lamination direction. On the other hand, the second end 42 is exposed from the board 20 to the lower side in the lamination direction. Specifically, while the whole of the conductor 40 is disposed on the board 20, the second end 42 extends through the board 20. With this configuration, of two of the coil sheets 10 adjacent in the lamination direction, the second end 42 of the conductor 40 disposed on the upper-side coil sheet 10 and the first end 41 of the conductor 40 disposed on the lower-side coil sheet 10 can be easily connected by the connecting portion 50 with a further shorter distance.

[0068] As described above, according to the present embodiment, the electromagnetic induction source 162 is formed by laminating the plurality of coil sheets 10 and connecting the ends of the conductors 40 respectively disposed on two of the coil sheets 10 adjacent in the lamination direction with the connecting portion 50. Therefore, by reducing the thickness of each coil sheet 10 or reducing the thickness of each conductor 40, the size of the electromagnetic induction source 162 can be easily reduced while the number of turns of a coil is maintained to maintain sufficient heating capability.

(2) Manufacturing Method for Electromagnetic Induction Source 162

[0069] FIG. 7 is a flowchart that illustrates an example of the flow of a manufacturing method for manufacturing the electromagnetic induction source 162 according to the present embodiment. Steps of the manufacturing method illustrated in this flow are, for example, performed by various manufacturing apparatuses deployed in a factory. A manufacturing apparatus that is an entity to perform each step may be different step by step. One step may be performed by a plurality of types of manufacturing apparatuses.

[0070] As illustrated in FIG. 7, initially, the manufacturing apparatus forms the plurality of coil sheets 10 (step S102). At this time, the manufacturing apparatus forms each of the plurality of coil sheets 10 by providing the through-hole 30 in the board 20 and disposing the conductor 40 having the first end 41 and the second end 42 as both ends so as to surround the through-hole 30. Through this step, for example, the coil sheet 10A to the coil sheet 10D described with reference to FIGS. 2 to 6 are formed.

[0071] Subsequently, the manufacturing apparatus laminates the plurality of coil sheets 10 in the lamination direction (step S104). At this time, the manufacturing apparatus disposes the plurality of coil sheets 10 such that the through-holes 30 respectively formed in the coil sheets 10 are lined up in the lamination direction. Through this step, for example, the coil sheet 10A to the coil sheet 10D are laminated as illustrated in FIG. 2 and the like.

[0072] The manufacturing apparatus electrically connects the second end 42 of the conductor 40 disposed on the coil sheet 10 located on the upper side in the lamination direction with the first end 41 of the conductor 40 disposed on the coil sheet 10 located on the lower side in the lamination direction, of two of the coil sheets 10 adjacent in the lamination direction for all the combinations of two of the coil sheets 10 adjacent in the lamination direction (step S106). Through this step, for example, for each of the combination of the coil sheet 10A and the coil sheet 10B, the combination of the coil sheet 10B and the coil sheet 10C, and the combination of the coil sheet 10C and the coil sheet 10D, the mutual conductors 40 are electrically connected. As a result, the electromagnetic induction source 162 illustrated in FIG. 2 and the like is manufactured.

[0073] With the manufacturing method described above, the electromagnetic induction source 162 according to the present embodiment is manufactured. With the manufacturing method, the electromagnetic induction source 162 can be manufactured by simply laminating the coil sheets 10 and electrically connecting the conductors 40 adjacent in the lamination direction. Therefore, in comparison with a method of manufacturing a coil by winding a conductive wire around a cylindrical winding shaft, a coil can be manufactured easily and precisely.

<4. Modifications>

(1) First Modification

[0074] The present modification is an example in which a seal that fills the gap between two of the coil sheets 10 adjacent in the lamination direction is disposed. The present modification will be described with reference to FIGS. 8 and 9.

First Example

[0075] FIG. 8 is a sectional view that illustrates an example of a cross section of the electromagnetic induction source 162 according to the present modification, taken along the line A-A in FIG. 2. As illustrated in FIG. 8, the electromagnetic induction source 162 may include one or more first seals 61 (61A to 61C). The first seal 61 seals the gap between two of the coil sheets 10 adjacent in the lamination direction on a side closer to the through-holes 30 than the conductors 40. For example, the first seal 61 may be formed in an annular shape to couple the through-holes 30 respectively formed in two of the coil sheets 10 adjacent in the lamination direction. With this configuration, it is possible to prevent foreign matter, such as an aerosol generated from the stick substrate 150, from flowing from the inside of the through-hole 30 to the conductor 40 side. Thus, the degradation of the conductor 40 can be prevented.

[0076] The space 31 formed by the plurality of through-holes 30 lined up in the lamination direction and the one or more first seals 61 may function as the internal space 141 of the holder 140. In other words, the holder 140 may be made up of the plurality of through-holes 30 lined up in the lamination direction and the one or more first seals 61. With this configuration, an additional holder 140 does not need to be disposed in the space 31, so the size of the inhaler device 100 can be further reduced.

Second Example

[0077] FIG. 9 is a sectional view that illustrates an example of a cross section of the electromagnetic induction source 162 according to the present modification, taken

along the line A-A in FIG. 2. As illustrated in FIG. 9, the electromagnetic induction source 162 may include one or more second seals 62 (62A to 62C). The second seal 62 seals the gap between two of the coil sheets 10 adjacent in the lamination direction on a side farther from the through-holes 30 than the conductors 40. For example, the first seal 61 is formed in an annular shape and disposed so as to cover the outer circumference of the conductor 40. With this configuration, it is possible to prevent foreign matter, such as dust and water droplets, from flowing from the outside of the electromagnetic induction source 162 to the conductor 40 side. Thus, the degradation of the conductor 40 can be prevented.

Supplement

[0078] The electromagnetic induction source 162 may have both the first seal 61 and the second seal 62.

(2) Second Modification

[0079] The present modification is an example in which a plurality of the electrically conducting paths 43 is provided in the conductor 40. The present modification will be described with reference to FIG. 10.

[0080] FIG. 10 is a top view that illustrates an example of the configuration of the coil sheet 10 according to the present modification. As illustrated in FIG. 10, the conductor 40 may have a plurality of electrically conducting paths 43 between the first end 41 and the second end 42. In the example illustrated in FIG. 10, the conductor 40 has two electrically conducting paths 43, that is, an electrically conducting path 43-1 and an electrically conducting path 43-2. The plurality of electrically conducting paths 43 may be disposed in parallel so as to be spaced apart in a direction orthogonal to the lamination direction. In the example illustrated in FIG. 10, each of the electrically conducting path 43-1 and the electrically conducting path 43-2 is formed in an annular shape and disposed in parallel in a radial direction of the through-hole 30. With this configuration, it is possible to increase the magnetic flux strength of a varying magnetic field that is generated from the electromagnetic induction source 162 by increasing the amount of current passing through the electromagnetic induction source 162. Thus, it is possible to further rapidly increase the temperature of the susceptor 161.

(3) Third Modification

[0081] The present modification is an example in which the length of the connecting portion 50 is set to the shortest length by shifting the positions of the conductors 40 between two coil sheets 10 to be laminated. The present modification will be described with reference to FIGS. 11 and 12.

[0082] FIG. 11 is a top view that illustrates an example of two coil sheets 10 adjacent in the lamination direction of the plurality of coil sheets 10 included in the electromagnetic induction source 162 according to the present modification. It is assumed that the coil sheet 10B is laminated under the coil sheet 10A. FIG. 12 is a sectional view of the coil sheet 10A and the coil sheet 10B of a cross section of the electromagnetic induction source 162 according to the present modification, taken along the line C-C in FIG. 11.

[0083] As illustrated in FIGS. 11 and 12, two of the coil sheets 10 adjacent in the lamination direction are disposed such that the second end 42A of the conductor 40A disposed on the coil sheet 10A located on the upper side in the lamination direction and the first end 41B of the conductor 40B disposed on the coil sheet 10B located on the lower side in the lamination direction substantially overlap in the lamination direction. In other words, in a state where the coil sheet 10A and the coil sheet 10B are laminated, the second end 42A and the first end 41B are disposed so as to overlap each other in plan view. Here, the phrase "substantially overlap in the lamination direction" means that at least part of the second end 42A and at least part of the first end 41B overlap in the lamination direction. With this configuration, the first end 41B is located directly below the second end 42A. Therefore, in the present modification, in comparison with the example illustrated in FIG. 6, the length of the connecting portion 50 can be shortened. In the present modification, the second end 42A and the first end 41B can be further easily connected by, for example, welding. Therefore, in the present modification, in comparison with the example illustrated in FIG. 6, the electromagnetic induction source 162 can be easily manufactured.

<5. Supplement>

[0084] The preferred embodiment of the present invention has been described in detail with reference to the attached drawings; however, the present invention is not limited to those examples. It is obvious that persons having ordinary skill in the art in the field of technology to which the present invention belongs can conceive of various modifications or alterations within the scope of the technical idea recited in the claims, and these can also be naturally interpreted as belonging to the technical scope of the present invention.

[0085] For example, in the above embodiment, an example in which the conductor 40 is disposed on the board 20 has been described; however, the present invention is not limited to this example. The conductor 40 may be embedded in the board 20. Even in this case, the first end 41 may be exposed from the board 20 to the upper side in the lamination direction, and the second end 42 may be exposed from the board 20 to the lower side in the lamination direction.

[0086] For example, in the above embodiment, an example in which the susceptor 161 is pieces of metal has been described; however, the present invention is not limited to this example. For example, the susceptor 161

may be formed in a long shape, such as a rod shape, a cylinder shape, and a sheet shape. In this case, the susceptor 161 is desirably disposed at the center of the substrate 151 along the longitudinal direction of the substrate 151. With this configuration, since the susceptor 161 that emits high heat as a result of induction heating is disposed at the center of the substrate 151, it is possible to generate an aerosol in a short period of time from the start of heating. Of course, the susceptors 161 respectively formed in multiple types of shape may be mixedly included in the substrate 151.

[0087] For example, in the above embodiment, an example in which the susceptor 161 is included in the substrate 151 has been described; however, the present invention is not limited to this example. In other words, the susceptor 161 can be disposed at any position at which the susceptor 161 is in thermal proximity to the aerosol source. In an example, the susceptor 161 may be formed in a blade shape and disposed so as to protrude from the bottom 143 of the holder 140 into the internal space 141. When the stick substrate 150 is inserted into the holder 140, the stick substrate 150 is inserted such that the blade-shaped susceptor 161 sticks into the substrate 151 from an end of the stick substrate 150 in an insertion direction. In another example, the susceptor 161 may be disposed at an inner wall of the holder 140, forming the internal space 141.

[0088] For example, in the above embodiment, an example in which one electromagnetic induction source 162 is assembled to the inhaler device 100 has been described; however, the present invention is not limited to this example. A plurality of the electromagnetic induction sources 162 may be assembled to the inhaler device 100.

[0089] For example, in the above embodiment, an example in which the electromagnetic induction source 162 is assembled to the inhaler device 100 such that the upper side in the lamination direction is a side closer to the opening 142 and the lower side in the lamination direction is a side farther from the opening 142 has been described; however, the present invention is not limited to this example. For example, the electromagnetic induction source 162 may be assembled to the inhaler device 100 such that the upper side in the lamination direction is a side farther from the opening 142 and the lower side in the lamination direction is a side closer to the opening 142. In this case, the conductor 40 located on the side closest to the opening 142 (that is, in the lowest layer) is covered with the board 20 when viewed from the opening 142 side, so the conductor 40 can be protected.

[0090] A series of pieces of processing, executed by the devices, described in the specification, may be implemented by any one of software, hardware, and a combination of software and hardware. Programs that are components of software are prestored in, for example, storage media (non-transitory media) provided inside or outside the devices. The programs are, for example, loaded onto a RAM when a computer that controls the devices described in the specification runs the programs and are run on a processor, such as a CPU. Examples of the storage media include a magnetic disk, an optical disk, a magneto-optical disk, and a flash memory. The computer programs may be distributed via, for example, a network, without using storage media.

[0091] Pieces of processing described by using the flowchart and the sequence diagram in the specification may be not necessarily executed in order as illustrated. Some processing steps may be executed in parallel. An additional processing step may be adopted, and part of the processing steps may be omitted.

[0092] The following configurations also belong to the technical scope of the present invention.

(1) An inhaler device includes

a power supply that supplies electric power,
a container capable of accommodating a substrate containing an aerosol source and a susceptor in thermal proximity to the aerosol source in an internal space, and
an electromagnetic induction source that generates a varying magnetic field in the internal space by using electric power supplied from the power supply, wherein
the electromagnetic induction source includes

a plurality of coil sheets laminated, and
one or more connecting portions,

each of the coil sheets has

a board,
a through-hole extending through the board in a lamination direction, and
a conductor having a first end and a second end as both ends and disposed on or in the board so as to surround the through-hole,

the connecting portion electrically connects the second end of the conductor disposed on or in the coil sheet located on an upper side in the lamination direction with the first end of the conductor disposed on or in the coil sheet located on a lower side in the lamination direction, of two of the coil sheets adjacent in the lamination direction, and
the first end of the conductor disposed on or in the coil sheet located on an uppermost side in the lamination direction and the second end of the conductor disposed on or in the coil sheet located on a lowermost side in the lamination direction are electrically connected to the power supply.

(2) In the inhaler device according to the above (1), the plurality of coil sheets is disposed such that the through-holes are lined up in the lamination direction.

(3) In the inhaler device according to the above (2),

the electromagnetic induction source includes one or more first seals, and
the first seal seals a gap between two of the coil sheets adjacent in the lamination direction on a side closer to the through-holes than the conductors.

(4) In the inhaler device according to the above (2) or (3),

the electromagnetic induction source includes one or more second seals, and
the second seal seals a gap between two of the coil sheets adjacent in the lamination direction on a side farther from the through-holes than the conductors.

(5) In the inhaler device according to any one of the above (2) to (4),
the container is disposed in a space formed by the plurality of through-holes lined up in the lamination direction.
(6) In the inhaler device according to the above (3), the container is made up of the plurality of through-holes lined up in the lamination direction and the one or more first seals.
(7) In the inhaler device according to any one of the above (1) to (6),
the conductor has a plurality of electrically conducting paths between the first end and the second end.
(8) In the inhaler device according to the above (7), the plurality of electrically conducting paths is disposed in parallel so as to be spaced apart from each other in a direction orthogonal to the lamination direction.
(9) In the inhaler device according to any one of the above (1) to (8),

the first end is exposed from the board to the upper side in the lamination direction, and
the second end is exposed from the board to the lower side in the lamination direction.

(10) In the inhaler device according to any one of the above (1) to (8),
two of the coil sheets adjacent in the lamination direction are disposed such that the second end of the conductor disposed on or in the coil sheet located on the upper side in the lamination direction and the first end of the conductor disposed on or in the coil sheet located on the lower side in the lamination direction substantially overlap each other in the lamination direction.
(11) An electromagnetic induction source that generates a varying magnetic field by using electric power supplied includes a plurality of coil sheets laminated, and

one or more connecting portions, wherein
each of the coil sheets has

a board,
a through-hole extending through the board in a lamination direction, and
a conductor having a first end and a second end as both ends and disposed on or in the board so as to surround the through-hole,

the connecting portion electrically connects the second end of the conductor disposed on or in the coil sheet located on an upper side in the lamination direction with the first end of the conductor disposed on or in the coil sheet located on a lower side in the lamination direction, of two of the coil sheets adjacent in the lamination direction, and
the first end of the coil sheet located on an uppermost side in the lamination direction and the second end of the coil sheet located on a lowermost side in the lamination direction are electrically connected to a power supply that supplies electric power

(12) A manufacturing method for manufacturing an electromagnetic induction source that generates a varying magnetic field by using electric power supplied includes

forming a plurality of coil sheets each of which includes a board, a through-hole extending through the board in a lamination direction, and a conductor having a first end and a second end as both ends and disposed on or in the board so as to surround the through-hole,
laminating the plurality of coil sheets in the lamination direction, and
electrically connecting the second end of the conductor disposed on or in the coil sheet located on an upper side in the lamination direction with the first end of the conductor disposed on or in the coil sheet located on a lower side in the lamination direction by a connecting portion, of two of the coil sheets adjacent in the lamination direction, for all combinations of two of the coil sheets adjacent in the lamination direction.

(13) A system includes an inhaler device and a substrate, wherein

the substrate contains an aerosol source,
the inhaler device includes

a power supply that supplies electric power,
a container capable of accommodating the

substrate and a susceptor in thermal proximity to the aerosol source in an internal space, and
an electromagnetic induction source that generates a varying magnetic field in the internal space by using electric power supplied from the power supply,

the electromagnetic induction source includes

a plurality of coil sheets laminated, and
one or more connecting portions,

each of the coil sheets has

a board,
a through-hole extending through the board in a lamination direction, and
a conductor having a first end and a second end as both ends and disposed on or in the board so as to surround the through-hole,

the connecting portion electrically connects the second end of the conductor disposed on or in the coil sheet located on an upper side in the lamination direction with the first end of the conductor disposed on or in the coil sheet located on a lower side in the lamination direction, of two of the coil sheets adjacent in the lamination direction, and
the first end of the conductor disposed on or in the coil sheet located on an uppermost side in the lamination direction and the second end of the conductor disposed on or in the coil sheet located on a lowermost side in the lamination direction are electrically connected to the power supply.

Reference Signs List

[0093]

100 inhaler device
111 power supply
112 sensor
113 notifier
114 memory
115 communicator
116 controller
140 holder
141 internal space
142 opening
143 bottom
150 stick substrate
151 substrate
152 inhalation port
161 susceptor
162 electromagnetic induction source
10 coil sheet
20 board
30 through-hole
31 space
40 conductor
41 first end
42 second end
43 electrically conducting path
50 connecting portion
61 first seal
62 second seal

Claims

1. An inhaler device comprising:

a power supply that supplies electric power;
a container capable of accommodating a substrate containing an aerosol source and a susceptor in thermal proximity to the aerosol source in an internal space; and
an electromagnetic induction source that generates a varying magnetic field in the internal space by using electric power supplied from the power supply, wherein
the electromagnetic induction source includes

a plurality of coil sheets laminated, and
one or more connecting portions,

each of the coil sheets has

a board,
a through-hole extending through the board in a lamination direction, and
a conductor having a first end and a second end as both ends and disposed on or in the board so as to surround the through-hole,

the connecting portion electrically connects the second end of the conductor disposed on or in the coil sheet located on an upper side in the lamination direction with the first end of the conductor disposed on or in the coil sheet located on a lower side in the lamination direction, of two of the coil sheets adjacent in the lamination direction, and
the first end of the conductor disposed on or in the coil sheet located on an uppermost side in the lamination direction and the second end of the conductor disposed on or in the coil sheet located on a lowermost side in the lamination direction are electrically connected to the power supply.

2. The inhaler device according to claim 1, wherein the plurality of coil sheets is disposed such that the

through-holes are lined up in the lamination direction.

3. The inhaler device according to claim 2, wherein

the electromagnetic induction source includes one or more first seals, and
the first seal seals a gap between two of the coil sheets adjacent in the lamination direction on a side closer to the through-holes than the conductors.

4. The inhaler device according to claim 2 or 3, wherein

the electromagnetic induction source includes one or more second seals, and
the second seal seals a gap between two of the coil sheets adjacent in the lamination direction on a side farther from the through-holes than the conductors.

5. The inhaler device according to any one of claims 2 to 4, wherein
the container is disposed in a space formed by the plurality of through-holes lined up in the lamination direction.

6. The inhaler device according to claim 3, wherein
the container is made up of the plurality of through-holes lined up in the lamination direction and the one or more first seals.

7. The inhaler device according to any one of claims 1 to 6, wherein
the conductor has a plurality of electrically conducting paths between the first end and the second end.

8. The inhaler device according to claim 7, wherein
the plurality of electrically conducting paths is disposed in parallel so as to be spaced apart from each other in a direction orthogonal to the lamination direction.

9. The inhaler device according to any one of claims 1 to 8, wherein

the first end is exposed from the board to the upper side in the lamination direction, and
the second end is exposed from the board to the lower side in the lamination direction.

10. The inhaler device according to any one of claims 1 to 8, wherein
two of the coil sheets adjacent in the lamination direction are disposed such that the second end of the conductor disposed on or in the coil sheet located on the upper side in the lamination direction and the first end of the conductor disposed on or in the coil sheet located on the lower side in the lamination direction substantially overlap each other in the lamination direction.

11. An electromagnetic induction source that generates a varying magnetic field by using electric power supplied, the electromagnetic induction source comprising:

a plurality of coil sheets laminated; and
one or more connecting portions, wherein
each of the coil sheets has

a board,
a through-hole extending through the board in a lamination direction, and
a conductor having a first end and a second end as both ends and disposed on or in the board so as to surround the through-hole,

the connecting portion electrically connects the second end of the conductor disposed on or in the coil sheet located on an upper side in the lamination direction with the first end of the conductor disposed on or in the coil sheet located on a lower side in the lamination direction, of two of the coil sheets adjacent in the lamination direction, and
the first end of the coil sheet located on an uppermost side in the lamination direction and the second end of the coil sheet located on a lowermost side in the lamination direction are electrically connected to a power supply that supplies electric power.

12. A manufacturing method for manufacturing an electromagnetic induction source that generates a varying magnetic field by using electric power supplied, the manufacturing method comprising:

forming a plurality of coil sheets each of which includes a board, a through-hole extending through the board in a lamination direction, and a conductor having a first end and a second end as both ends and disposed on or in the board so as to surround the through-hole;
laminating the plurality of coil sheets in the lamination direction; and
electrically connecting the second end of the conductor disposed on or in the coil sheet located on an upper side in the lamination direction with the first end of the conductor disposed on or in the coil sheet located on a lower side in the lamination direction by a connecting portion, of two of the coil sheets adjacent in the lamination direction, for all combinations of two of the coil sheets adjacent in the lamination direction.

13. A system comprising an inhaler device and a sub-

strate, wherein

the substrate contains an aerosol source,
the inhaler device includes

a power supply that supplies electric power,
a container capable of accommodating the substrate and a susceptor in thermal proximity to the aerosol source in an internal space, and
an electromagnetic induction source that generates a varying magnetic field in the internal space by using electric power supplied from the power supply,

the electromagnetic induction source includes

a plurality of coil sheets laminated, and
one or more connecting portions,

each of the coil sheets has

a board,
a through-hole extending through the board in a lamination direction, and
a conductor having a first end and a second end as both ends and disposed on or in the board so as to surround the through-hole,

the connecting portion electrically connects the second end of the conductor disposed on or in the coil sheet located on an upper side in the lamination direction with the first end of the conductor disposed on or in the coil sheet located on a lower side in the lamination direction, of two of the coil sheets adjacent in the lamination direction, and
the first end of the conductor disposed on or in the coil sheet located on an uppermost side in the lamination direction and the second end of the conductor disposed on or in the coil sheet located on a lowermost side in the lamination direction are electrically connected to the power supply.

FIG. 1

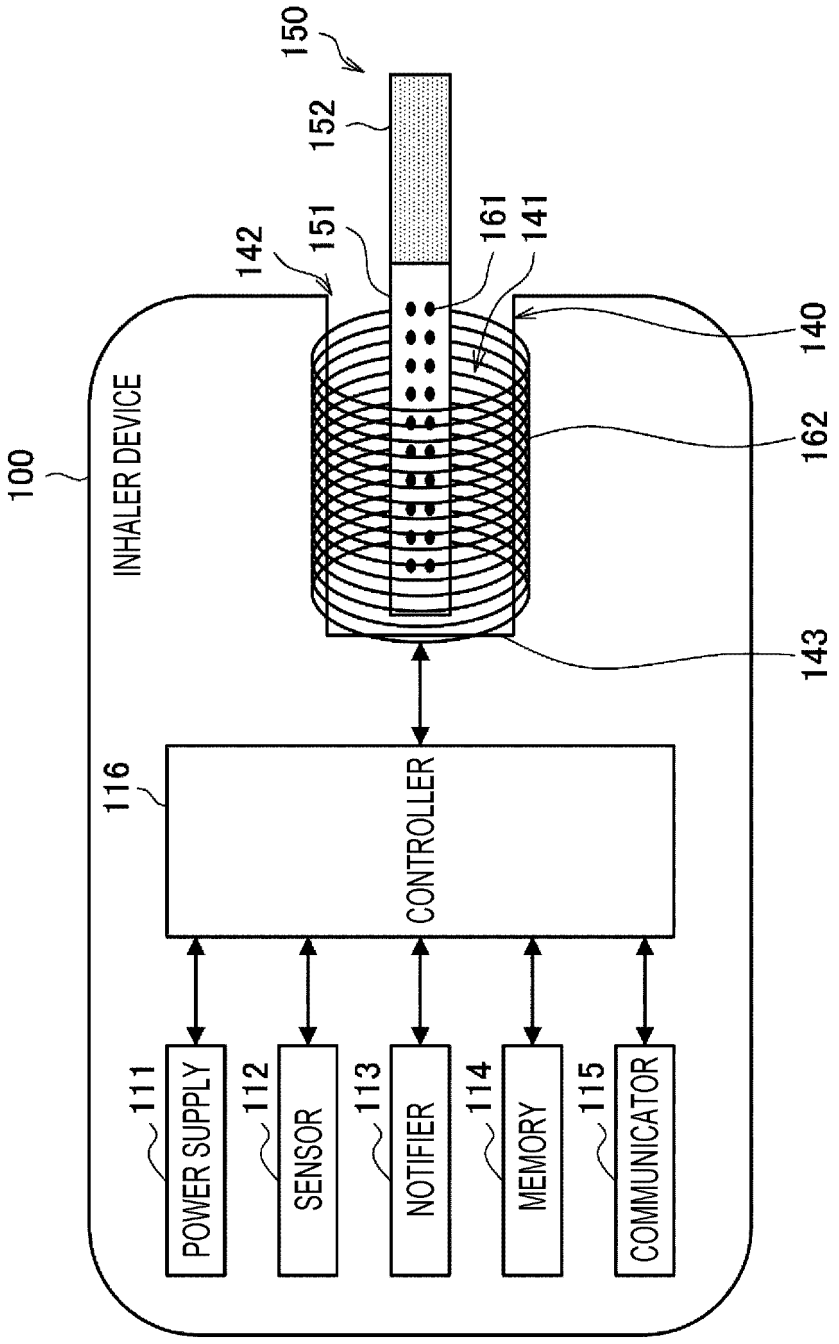

150
152
151
142
161
141
140
162
143
100
INHALER DEVICE
116
CONTROLLER
111
POWER SUPPLY
112
SENSOR
113
NOTIFIER
114
MEMORY
115
COMMUNICATOR

FIG. 2

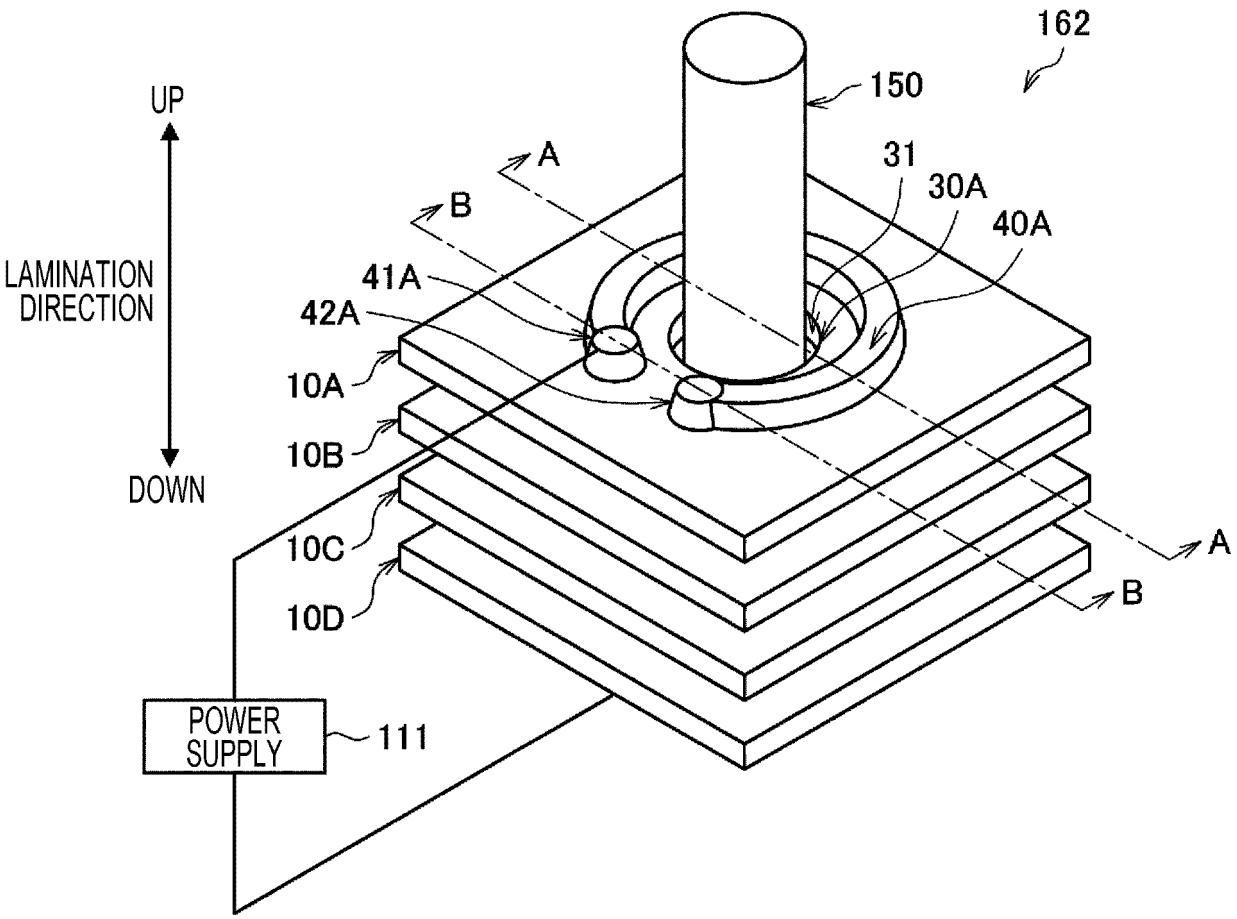

162
150
UP
LAMINATION DIRECTION
DOWN
A
B
31
30A
40A
41A
42A
10A
10B
10C
10D
A
B
POWER SUPPLY
111

FIG. 3

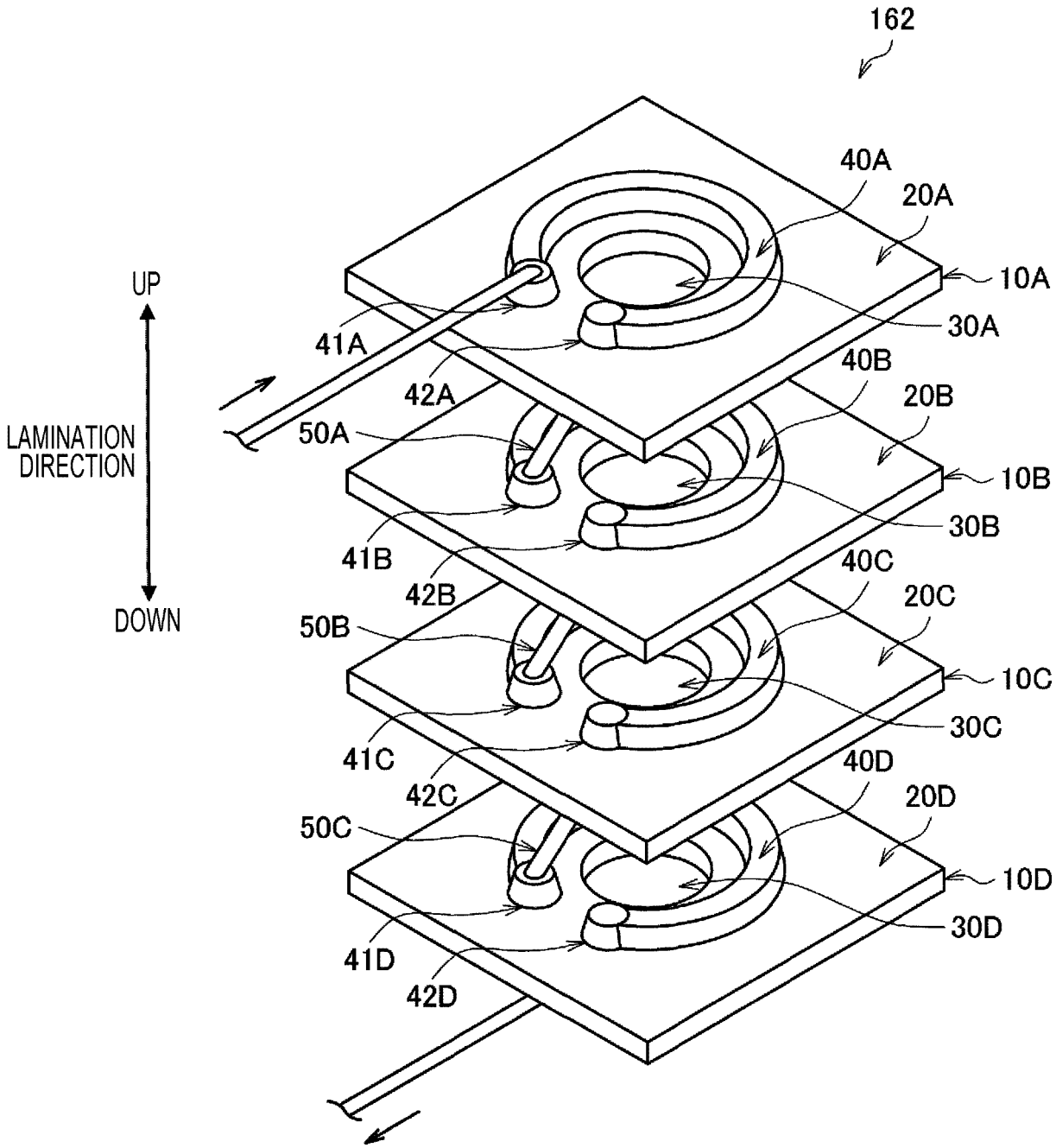

162
40A
20A
10A
30A
41A
42A
50A
40B
20B
10B
30B
41B
42B
50B
40C
20C
10C
30C
41C
42C
50C
40D
20D
10D
30D
41D
42D
UP
LAMINATION DIRECTION
DOWN

FIG. 4

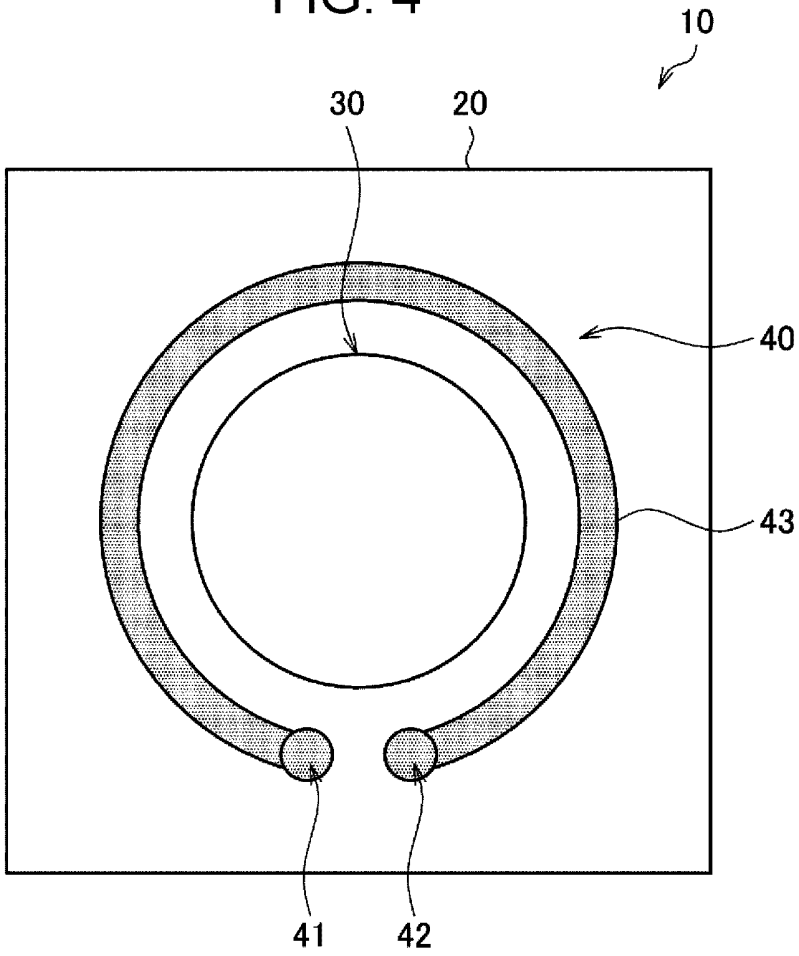

10
30
20
40
43
41
42

FIG. 5

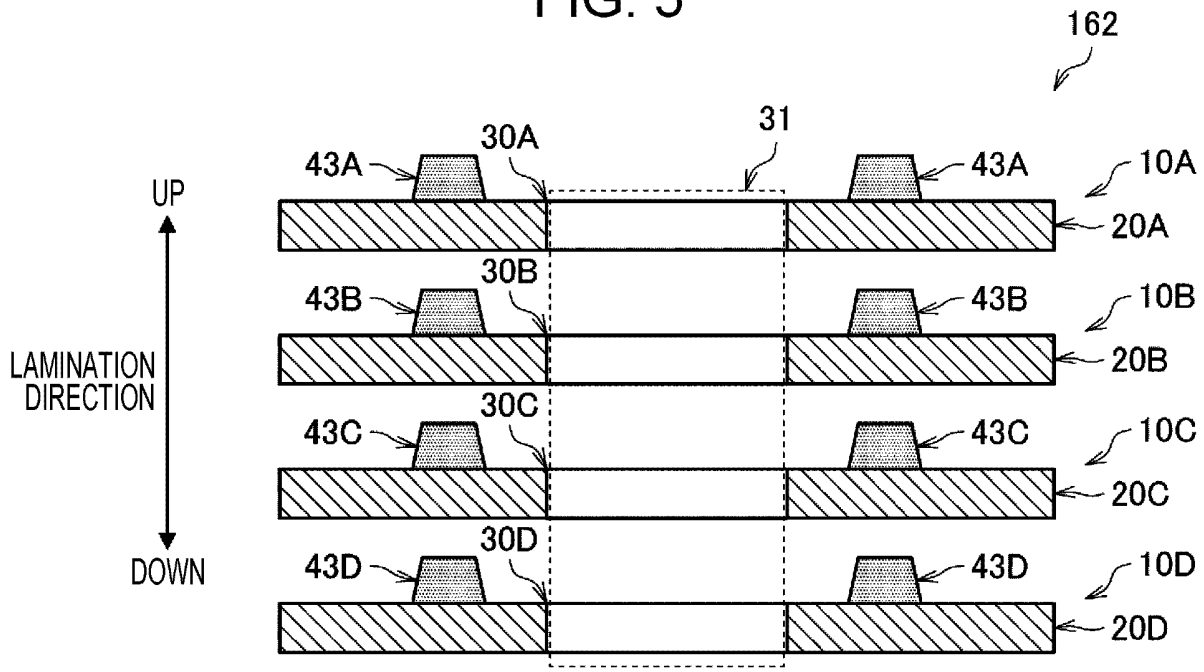

162
31
30A
43A
43A
10A
20A
UP
LAMINATION DIRECTION
DOWN
30B
43B
43B
10B
20B
30C
43C
43C
10C
20C
30D
43D
43D
10D
20D

FIG. 6

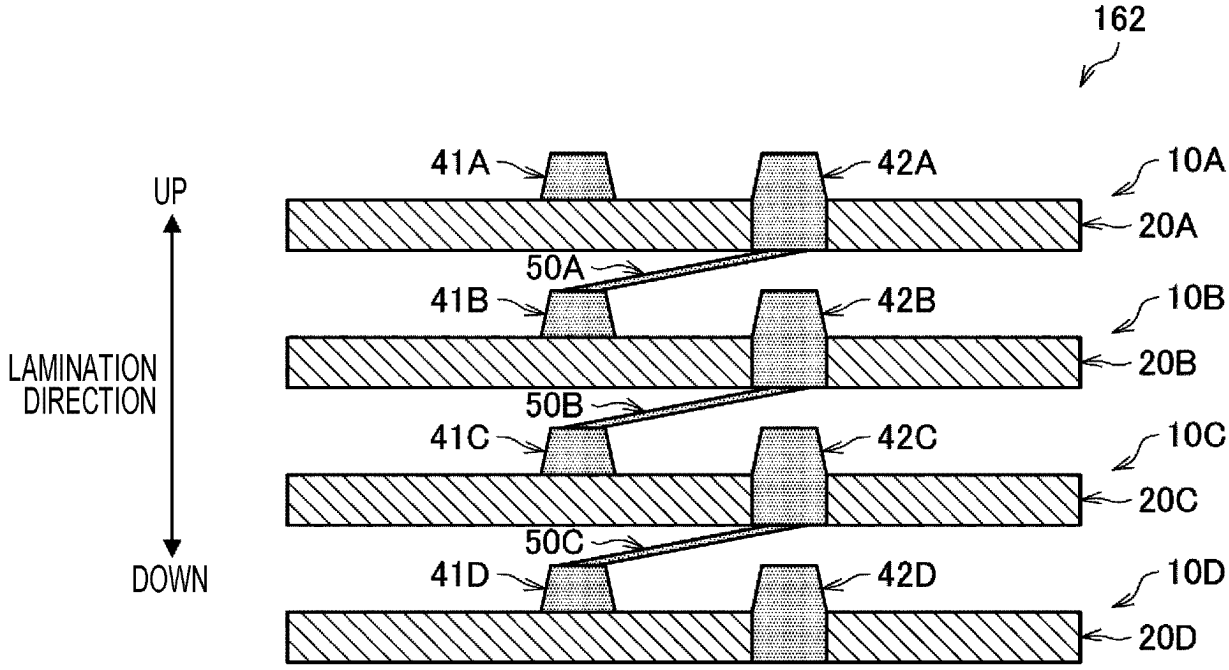

162
UP
LAMINATION DIRECTION
DOWN
41A
42A
10A
20A
50A
41B
42B
10B
20B
50B
41C
42C
10C
20C
50C
41D
42D
10D
20D

FIG. 7

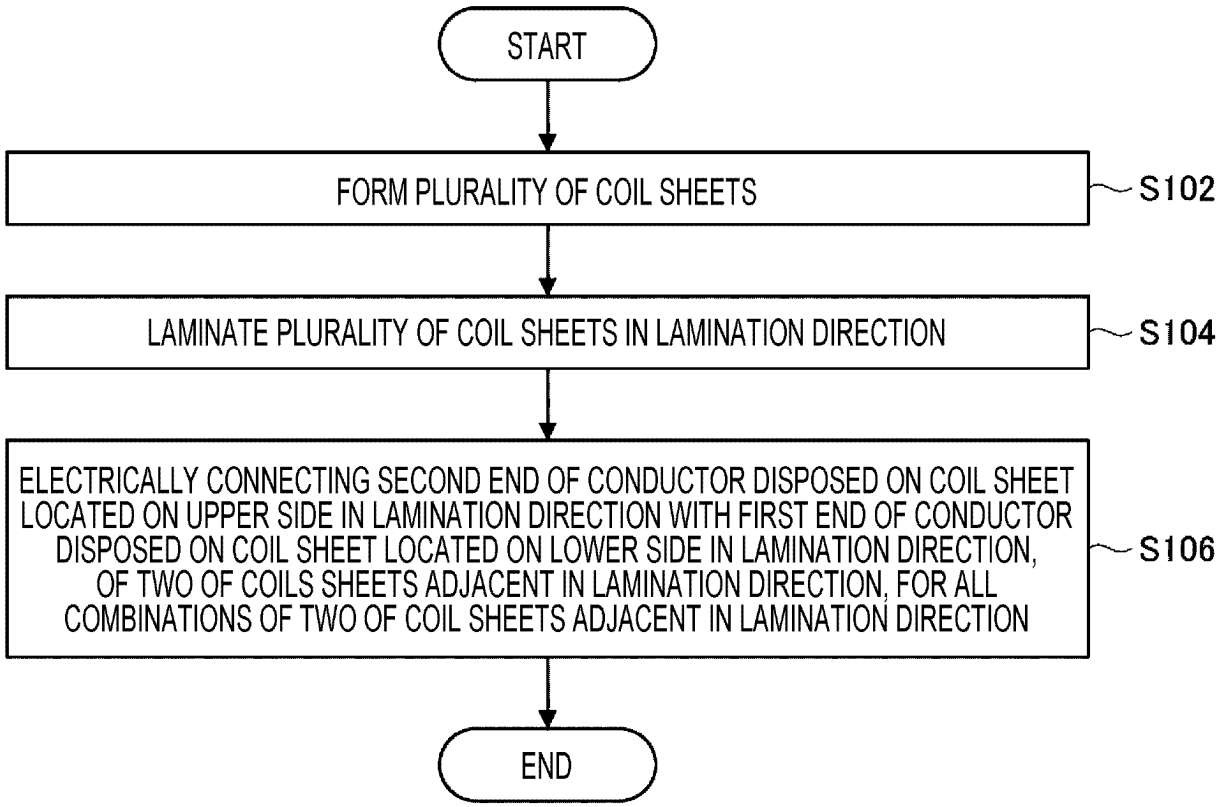

START
FORM PLURALITY OF COIL SHEETS
S102
LAMINATE PLURALITY OF COIL SHEETS IN LAMINATION DIRECTION
S104
ELECTRICALLY CONNECTING SECOND END OF CONDUCTOR DISPOSED ON COIL SHEET LOCATED ON UPPER SIDE IN LAMINATION DIRECTION WITH FIRST END OF CONDUCTOR DISPOSED ON COIL SHEET LOCATED ON LOWER SIDE IN LAMINATION DIRECTION, OF TWO OF COILS SHEETS ADJACENT IN LAMINATION DIRECTION, FOR ALL COMBINATIONS OF TWO OF COIL SHEETS ADJACENT IN LAMINATION DIRECTION
S106
END

FIG. 8

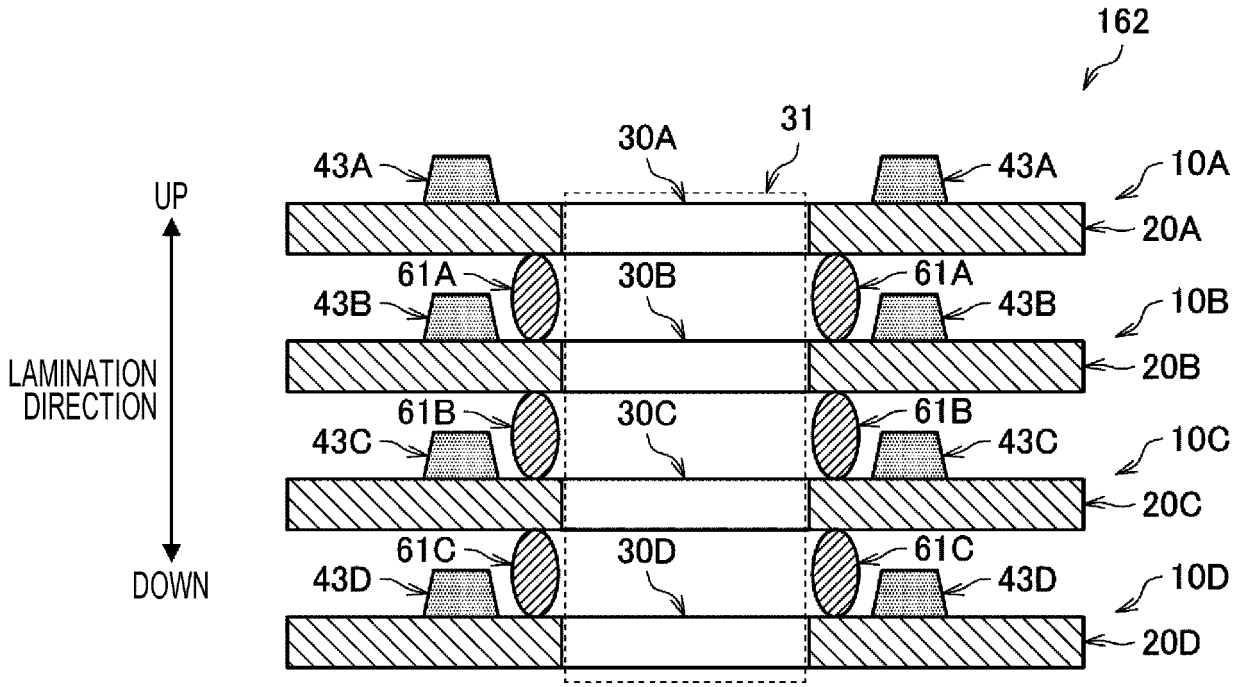

162
31
30A
43A
43A
10A
20A
UP
61A
30B
61A
43B
43B
10B
20B
LAMINATION DIRECTION
61B
30C
61B
43C
43C
10C
20C
61C
30D
61C
43D
43D
10D
20D
DOWN

FIG. 9

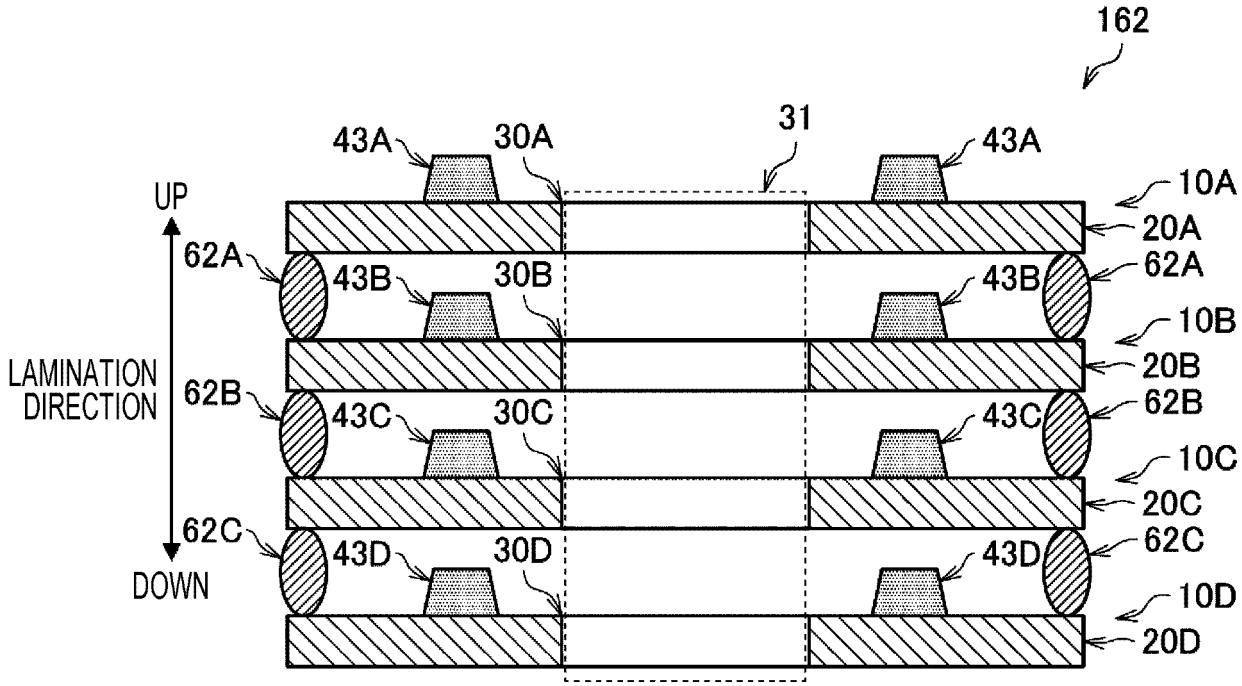

162
31
43A
30A
43A
10A
20A
UP
62A
43B
30B
43B
62A
10B
20B
LAMINATION DIRECTION
62B
43C
30C
43C
62B
10C
20C
62C
43D
30D
43D
62C
10D
20D
DOWN

FIG. 10

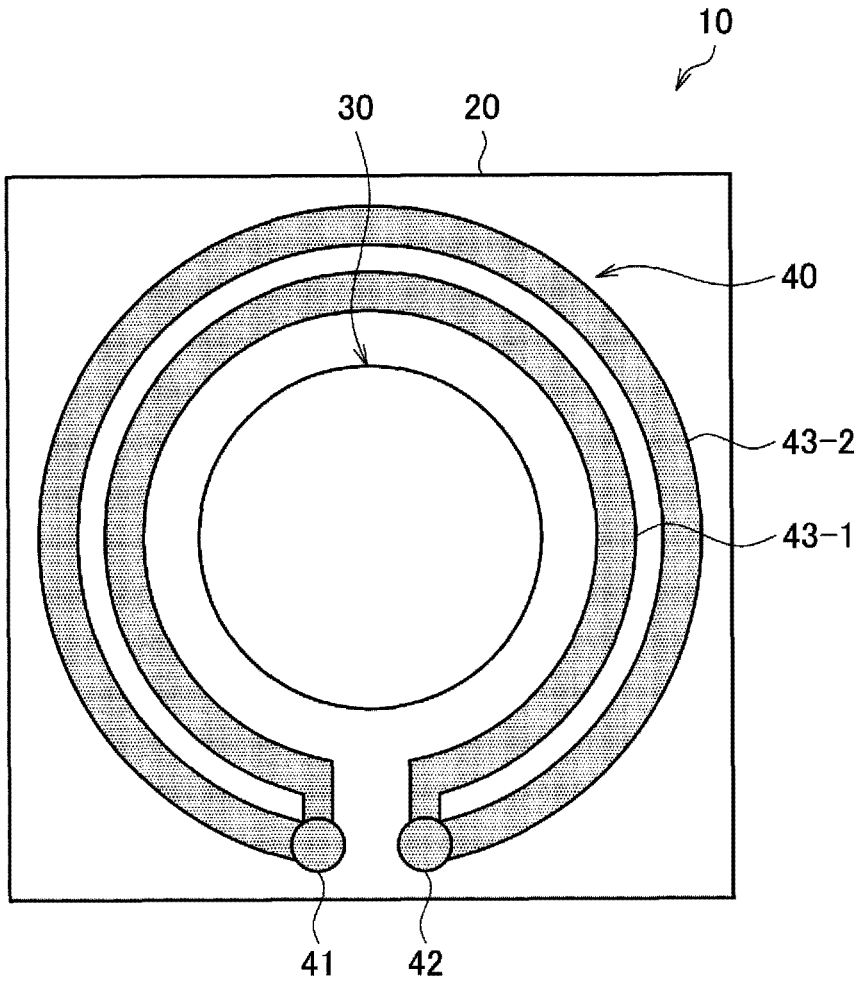


FIG. 11

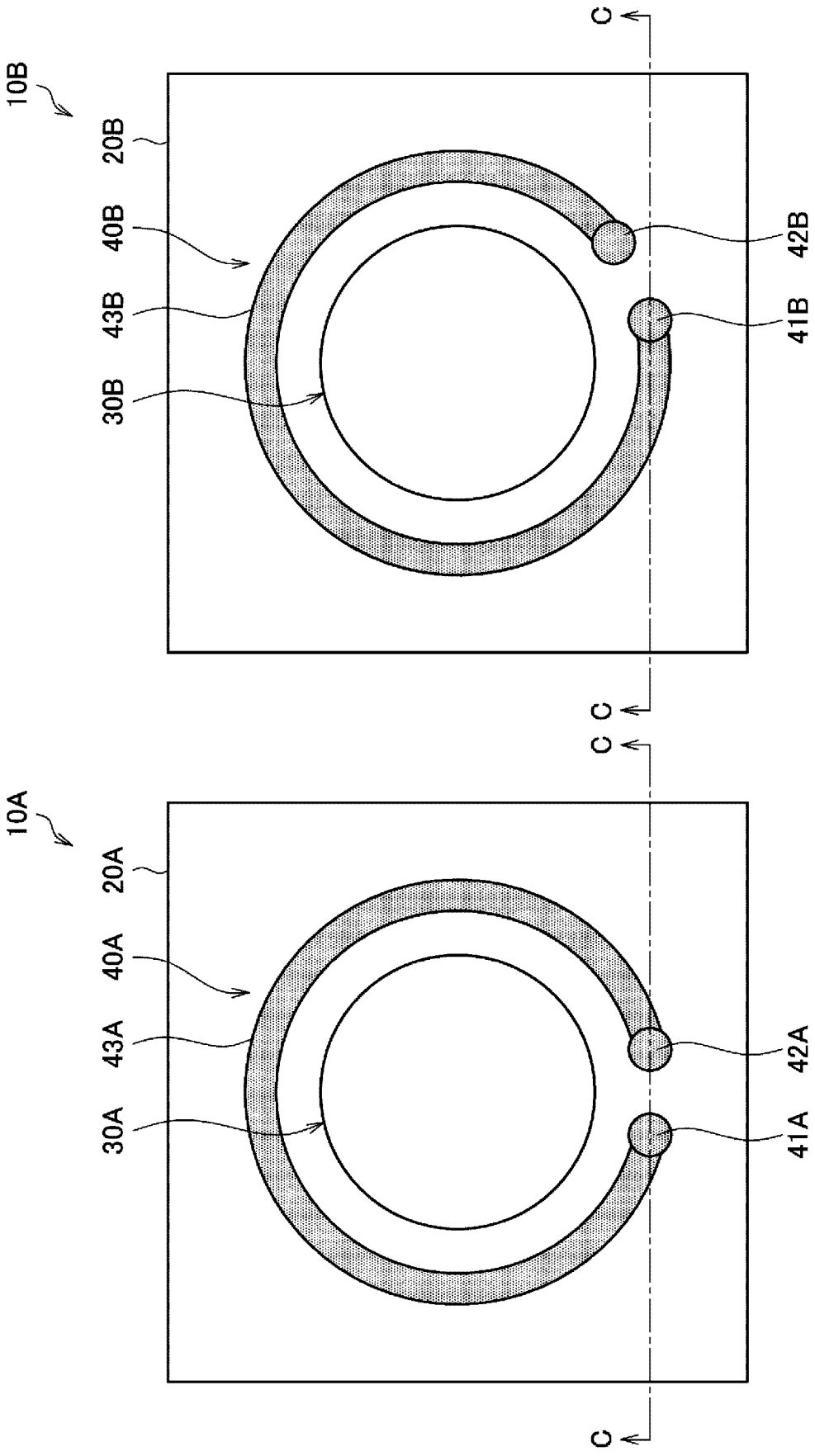
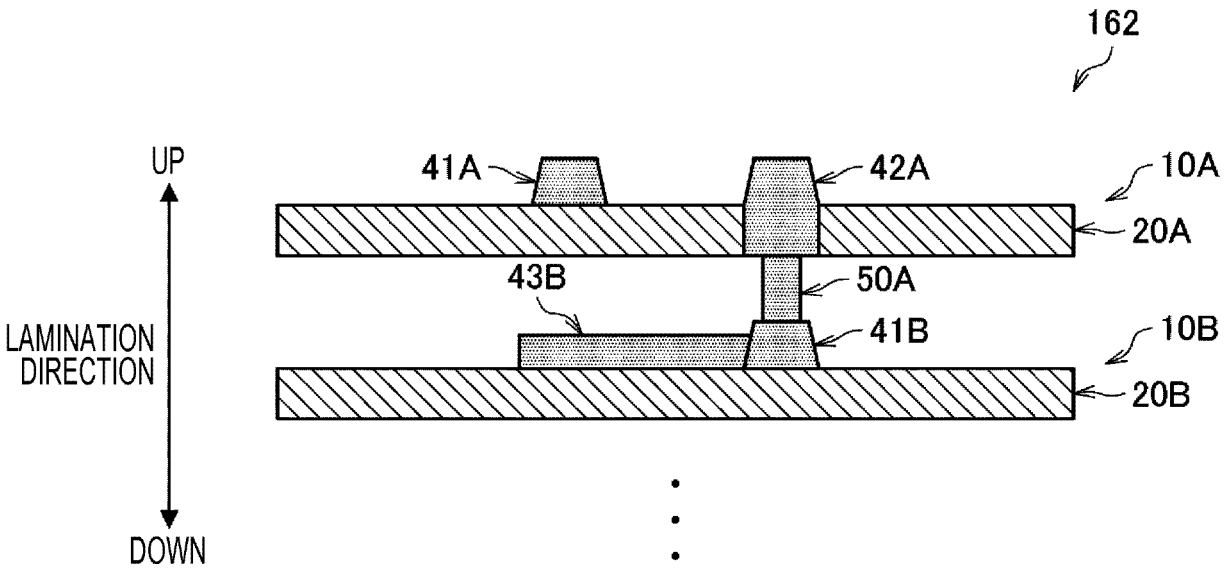


FIG. 12


162
UP
LAMINATION DIRECTION
DOWN
41A
42A
10A
20A
43B
50A
41B
10B
20B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2021/011472

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. A24F40/465(2020.01)i
FI: A24F40/465

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. A24F40/465

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2021
Registered utility model specifications of Japan	1996-2021
Published registered utility model applications of Japan	1994-2021

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2020-512657 A (BRITISH AMERICAN TOBACCO (INVESTMENTS) LTD.) 23 April 2020 (2020-04-23), paragraphs [0038]-[0071], fig. 1-5	1-13
Y	WO 2012/033136 A1 (TDK CORP.) 15 March 2012 (2012-03-15), paragraph [0003], fig. 28, 29	1-13
Y	WO 2015/152333 A1 (MURATA MANUFACTURING CO., LTD.) 08 October 2015 (2015-10-08), paragraphs [0022]-[0032], fig. 2	1-13

☐ 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	Date of mailing of the international search report
14.05.2021	25.05.2021
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2021/011472

Patent Documents referred to in the Report	Publication Date	Patent Family	Publication Date
JP 2020-512657 A	23.04.2020	WO 2018/178095 A1 p. 8, line 1 to p. 18, line 3, fig. 1-5 EP 3603336 A1 CN 110447303 A KR 10-2019-0124748 A	
WO 2012/033136 A1	15.03.2012	US 2012/0313743 A1 paragraph [0003], fig. 28, 29 CN 102985983 A	
WO 2015/152333 A1	08.10.2015	US 2017/0011838 A1 paragraphs [0038]-[0049], fig. 2 CN 206532662 U	

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 6623175 B **[0004]**