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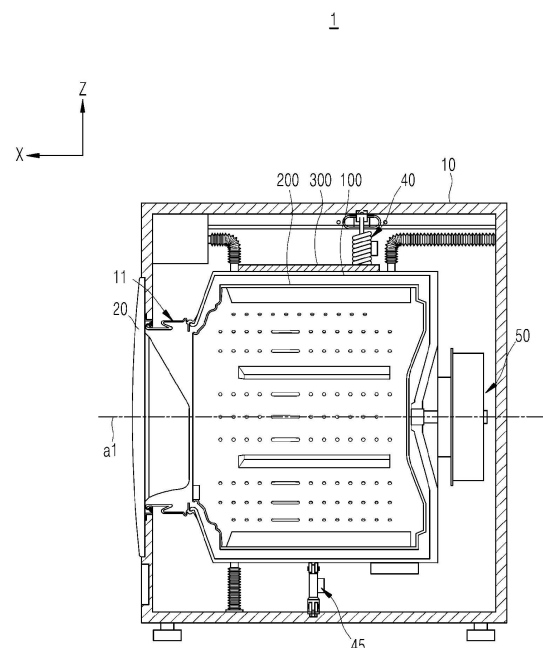
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(54) **CLOTHING TREATMENT APPARATUS**

(57) The clothing treatment apparatus according to one embodiment of the present disclosure includes a tub, a drum, and an induction module. The induction module includes a working coil and permanent magnets. The induction module is arranged such that a center of the induction module is located on a second reference plane that forms, with a first reference plane, a predetermined angle. The induction module includes, with respect to the second reference plane, a first group that is a combination of permanent magnets disposed in a first region and a second group that is a combination of permanent magnets disposed in a second region, and the magnetic force of the second group is greater than the magnetic force of the first group. Each permanent magnet allows a magnetic field generated by the working coil to be concentrated toward the drum, and, even when the induction module is asymmetrically arranged with respect to the first reference plane, the permanent magnets may alleviate asymmetry in magnetic flux and allow the magnetic field and the magnetic flux to be concentrated toward the drum.

[FIG. 1]



Description

TECHNICAL FIELD

5 **[0001]** The present disclosure relates to a clothing treatment apparatus that heats a drum accommodating clothing or laundry by using an induction module, and more particularly, to a clothing treatment apparatus provided with permanent magnets so that a magnetic field generated by a working coil of the induction module may be concentrated toward the drum.

10 BACKGROUND

[0002] A clothing treatment apparatus may be configured to wash, dry, and/or refresh clothing, laundry, and the like.

[0003] A washing machine configured to wash clothing, a dryer configured to dry clothing, a refresher configured to refresh clothing, and the like are examples of clothing treatment apparatuses.

15 **[0004]** There are also clothing treatment apparatuses in which a plurality of treatments among washing, drying, and refreshing are performed in a single apparatus. A representative example is a clothing treatment apparatus capable of both washing and drying.

[0005] A clothing treatment apparatus may be provided with a heating means for heating wash water, clothing, or air inside the apparatus.

20 **[0006]** An electric heater, a gas heater, a heat pump, and the like may be used as the heating means of the clothing treatment apparatus.

[0007] Recently, clothing treatment apparatuses provided with an induction module as a means for heating the drum of a clothing treatment apparatus have been disclosed.

25 **[0008]** The induction module heats the drum by an induction heating method, whereby wash water, clothing, or air inside the drum may be effectively heated.

[0009] That is, the drum may be heated by supplying current to a working coil of the induction module through electromagnetic induction. When a high-frequency alternating current flows through the working coil, a magnetic field is generated in the working coil, and by the electromagnetic induction effect caused by the magnetic field, an eddy current is induced in the drum, which is an object to be heated, and heat is generated in the resistance component of the drum by the eddy current, thereby heating the drum.

30 **[0010]** In this way, the drum is heated by the magnetic field generated by the working coil of the induction module. However, since the magnetic field generated by the working coil may also be formed toward the exterior of the drum, electromagnetic interference (EMI) noise may be generated.

35 **[0011]** In a clothing treatment apparatus, the drum is configured to rotate, and the induction module is installed spaced apart from the drum. Since a gap between the drum and the induction module is relatively large, more noise may be radiated outward.

[0012] In addition, when the induction module is not disposed at the upper center of the drum but is provided offset in one direction (e.g., to the left or right) and tilted, the noise caused by the magnetic field in one direction may have a different value from the noise caused by the magnetic field in the opposite direction.

40 **[0013]** Products using an induction module must pass a radiated disturbance test standard for a predetermined frequency band (9 kHz to 30 MHz). However, when the induction module is not disposed at the center of the drum but is provided offset in one direction and tilted, an issue may arise in which radiated noise increases in the opposite direction.

45 **[0014]** As such, depending on the placement position of the induction module in the clothing treatment apparatus, an issue may arise in which noise caused by the magnetic field in one direction of the clothing treatment apparatus may become greater.

DISCLOSURE

50 TECHNICAL PROBLEM

[0015] The present disclosure is directed to preventing an increase in magnetic field noise radiated to the exterior of a clothing treatment apparatus while minimizing an increase in the number or quantity of permanent magnets, and to providing a clothing treatment apparatus that, when an induction module is not disposed at the center of a drum in a left-right direction but is disposed offset in one direction and tilted, is capable of preventing an increase in magnetic field noise in the opposite direction, and in which a magnetic field and magnetic flux may be concentrated toward the drum.

[0016] The present disclosure is further directed to providing a clothing treatment apparatus in which, when an

induction module is not disposed at the center of a drum in a left-right direction but is provided offset in one direction and tilted, and when permanent magnets disposed on opposite sides outside a working coil are identical to each other, the permanent magnets are arranged to prevent an increase in magnetic field noise in one direction and to allow a magnetic field and magnetic flux to be concentrated toward the drum.

TECHNICAL SOLUTION

[0017] The clothing treatment apparatus described in the present application includes a tub, a drum comprising a metal material, provided with a space for accommodating laundry therein, and provided inside the tub so as to be rotatable about a rotation axis extending in a first direction, and an induction module fixedly coupled to the tub, the induction module including a working coil configured to heat the drum through a magnetic field when current is applied, and a plurality of permanent magnets provided adjacent to an outer side of the working coil.

[0018] The induction module is arranged such that a center of the induction module is located on a second reference plane that forms, with a vertical first reference plane passing through the rotation axis, a predetermined angle about the rotation axis in a first rotation direction.

[0019] The induction module includes a first group that is a combination of one or more of the permanent magnets disposed in a first region that is located, with respect to the second reference plane, on a side toward the first rotation direction, and a second group that is a combination of one or more of the permanent magnets disposed in a second region that is located, with respect to the second reference plane, on a side toward a direction opposite to the first rotation direction.

[0020] The magnetic force of the second group is greater than the magnetic force of the first group.

[0021] When the plurality of permanent magnets are identical to one another, the number of permanent magnets in the second group may be greater than the number of permanent magnets in the first group.

[0022] The working coil may be wound about a center axis extending along the second reference plane and passing through the center of the induction module, and the plurality of permanent magnets may be arranged to be orthogonal to a direction in which the working coil is wound.

[0023] The plurality of permanent magnets may be disposed within a region formed by the working coil.

[0024] The plurality of permanent magnets may be arranged symmetrically with respect to a third reference plane that is perpendicular to the first reference plane and passes through the center axis.

[0025] The plurality of permanent magnets may include first magnets and second magnets.

[0026] The first magnets are one or more of the permanent magnets belonging to the first group and parallel to the third reference plane.

[0027] The second magnets are one or more of the permanent magnets belonging to the second group and parallel to the third reference plane.

[0028] The first magnets and the second magnets may be identical to one another.

[0029] A ratio of a number of the second magnets to a number of the first magnets may range from 2 to 4.

[0030] The plurality of permanent magnets may include a third magnet disposed on one side with respect to the third reference plane, and a fourth magnet disposed on an opposite side from the third magnet with respect to the third reference plane.

[0031] In one embodiment of the present disclosure, the angle (θ) may range from 5° to 15° .

[0032] In one embodiment of the present disclosure, the angle (θ) may be 5° , and the ratio may be 2.5.

[0033] The clothing treatment apparatus according to one embodiment of the present disclosure may be configured such that, when a value of the angle (deg) is plotted on an x-axis and a value of the ratio is plotted on a y-axis, a point defined by the value of the angle (deg) and the value of the ratio lies on a graph passing through (10, 3) and having a slope of 1/10.

[0034] The working coil is arranged such that a center of the working coil is located on a second reference plane that forms, with a vertical first reference plane passing through the rotation axis, a predetermined angle about the rotation axis in a first rotation direction.

[0035] The working coil may be divided into a first coil portion located, with respect to the second reference plane, on a side toward the first rotation direction, and a second coil portion located, with respect to the second reference plane, on a side toward a direction opposite to the first rotation direction.

[0036] An area of the second coil portion shielded by the permanent magnets may be greater than an area of the first coil portion shielded by the permanent magnets.

[0037] The plurality of permanent magnets may all be identical to one another, and the number of permanent magnets provided on an outer side of the second coil portion may be greater than the number of permanent magnets provided on an outer side of the first coil portion.

[0038] The drum may have a cylindrical shape centered about the rotation axis, and the induction module may be fixed to an outer surface of the tub.

[0039] In the clothing treatment apparatus according to one embodiment of the present disclosure, the first direction may be parallel to a front-rear direction or may be inclined by 15° or less with respect to the front-rear direction.

[0040] The induction module may be located above the drum.

[0041] In the clothing treatment apparatus according to one embodiment of the present disclosure, the working coil may be configured to intersect the first reference plane.

[0042] The induction module may include a base housing and a magnet base.

[0043] The base housing is fixedly coupled to an outer surface of the tub, and the working coil is accommodated in the base housing.

[0044] Support grooves in which respective ones of the plurality of permanent magnets are accommodated are formed in the magnet base, and the magnet base may be fixedly coupled to an outer side of the base housing.

ADVANTAGEOUS EFFECTS OF INVENTION

[0045] The clothing treatment apparatus according to one embodiment of the present disclosure includes a tub, a drum, and an induction module. The induction module includes a working coil and permanent magnets. The induction module is arranged such that a center of the induction module is located on a second reference plane that forms, with a first reference plane, a predetermined angle. The induction module includes, with respect to the second reference plane, a first group that is a combination of permanent magnets disposed in a first region and a second group that is a combination of permanent magnets disposed in a second region, and the magnetic force of the second group is greater than the magnetic force of the first group. Each permanent magnet allows the magnetic field generated by the working coil to be concentrated toward the drum, and even when the induction module is arranged asymmetrically with respect to the first reference plane, the permanent magnets may alleviate asymmetry in magnetic flux, and allow the magnetic field and the magnetic flux to be concentrated toward the drum.

[0046] In the clothing treatment apparatus according to one embodiment of the present disclosure, when the induction module is arranged to be tilted to one side above the drum, an increase in noise in a direction opposite to the tilted side may be prevented.

[0047] In the clothing treatment apparatus according to one embodiment of the present disclosure, when the plurality of permanent magnets are identical to one another, the number of permanent magnets in the second group is greater than the number of permanent magnets in the first group. The permanent magnets in the second group may allow the magnetic field and magnetic flux of the working coil to be concentrated toward the drum to a greater extent than the permanent magnets in the first group, and may prevent an increase in noise caused by the magnetic field.

[0048] According to the clothing treatment apparatus according to one embodiment of the present disclosure, when designing the clothing treatment apparatus, a restriction requiring the induction module to be disposed at the exact center vertically above the drum may be avoided, and design freedom of the clothing treatment apparatus may be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0049]

FIG. 1 is a cross-sectional view schematically illustrating a clothing treatment apparatus according to one embodiment of the present disclosure.

FIG. 2 is a cross-sectional view schematically illustrating the clothing treatment apparatus according to one embodiment of the present disclosure.

FIG. 3 is a view schematically illustrating a state in which an induction module is installed above a tub in the clothing treatment apparatus according to one embodiment of the present disclosure.

FIG. 4 is an exploded view illustrating some components of an induction module according to one embodiment of the present disclosure.

FIG. 5 is a view illustrating an arrangement of a drum and an induction module in the clothing treatment apparatus according to one embodiment of the present disclosure.

FIG. 6 is a view illustrating, by simulation, a state in which a magnetic field acts when a drum and a working coil according to one embodiment of the present disclosure are provided and a permanent magnet (M) is provided on an outer side of the working coil.

FIG. 7A is a view illustrating, by simulation, a state in which a magnetic field acts when no permanent magnet is provided and a drum and a working coil are provided as in FIG. 6.

FIG. 7B is a view illustrating, by simulation, a state in which a magnetic field acts when a drum and a working coil are provided as in FIG. 6 and permanent magnets are provided on left and right outer sides of the working coil.

FIG. 7C is a view illustrating, by simulation, a state in which a magnetic field acts when a drum and a working coil

are provided as in FIG. 6 and a permanent magnet is provided only on a left outer side of the working coil.

FIG. 8 is a view illustrating, by simulation, a state in which a magnetic field acts when a drum and a working coil are provided as in FIG. 6, permanent magnets are provided on left and right outer sides of the working coil, and the magnetic force of the permanent magnet on the left side is smaller than the magnetic force of the permanent magnet on the right side.

FIG. 9A is a view illustrating, by simulation, a state in which a magnetic field acts when a drum and a working coil are provided as in FIG. 6, permanent magnets are provided on left and right outer sides of the working coil, and the magnetic force of the permanent magnet on the left side is greater than the magnetic force of the permanent magnet on the right side.

FIG. 9B is a view illustrating, by simulation, a state in which a magnetic field acts when a drum, a working coil, and permanent magnets are provided as in FIG. 9A, and the magnetic force of the permanent magnet on the left side is greater than the magnetic force of the permanent magnet on the left side in FIG. 9A.

FIG. 9C is a view illustrating, by simulation, a state in which a magnetic field acts when a drum, a working coil, and permanent magnets are provided as in FIG. 9B, and the magnetic force of the permanent magnet on the left side is greater than the magnetic force of the permanent magnet on the left side in FIG. 9B.

FIG. 10 is a view schematically illustrating arrangements of permanent magnets in an induction module.

FIG. 11 is a view illustrating a ratio of a number of second magnets to a number of first magnets according to an inclination angle of an induction module.

FIG. 12 is a view schematically illustrating a state in which noise of the clothing treatment apparatus according to one embodiment of the present disclosure is measured.

DETAILED DESCRIPTION

[0050] Hereinbelow, preferred embodiments of the present disclosure will be described in greater detail with reference to the accompanying drawings. In the following description, explanations of known functions or structures that may obscure the gist of the present disclosure are omitted.

[0051] FIG. 1 is a cross-sectional view schematically illustrating a clothing treatment apparatus (1) according to one embodiment of the present disclosure.

[0052] FIG. 2 is a cross-sectional view schematically illustrating the clothing treatment apparatus (1) according to one embodiment of the present disclosure.

[0053] FIG. 3 is a view schematically illustrating a state in which an induction module (300) is installed above a tub (100) in the clothing treatment apparatus (1) according to one embodiment of the present disclosure.

[0054] The clothing treatment apparatus (1) according to one embodiment of the present disclosure includes a tub (100), a drum (200), and an induction module (300). The clothing treatment apparatus (1) may include a casing (10).

[0055] In the clothing treatment apparatus (1) according to one embodiment of the present disclosure, the induction module (300) is configured to heat the drum (200), and accordingly may heat water, clothing, laundry, and/or air accommodated inside the drum (200). Such a clothing treatment apparatus (1) may also be referred to by other names. For example, the clothing treatment apparatus (1) according to one embodiment of the present disclosure may be used as a washing machine, or may be used as a dryer, or may be used as a washer-dryer, or may be used as a clothing care apparatus.

[0056] The casing (10) forms an exterior of the clothing treatment apparatus (1). The casing (10) may have an overall hexahedral shape. The casing (10) may have various shapes other than a hexahedral shape.

[0057] An inlet through which clothing, laundry, and the like are introduced is formed on one side surface (for example, a front surface) of the casing (10).

[0058] The tub (100) is disposed inside the casing (10). The tub (100) is formed in a container shape defining a predetermined space. The tub (100) may have a generally circular container shape, a polygonal container shape, or the like. One side (for example, a front surface) of the tub (100) is opened at a position corresponding to the inlet of the casing (10) to form an entrance.

[0059] Water may be contained inside the tub (100).

[0060] The entrance of the tub (100) and the inlet of the casing (10) may be connected to each other by a gasket (11), and a space between them may be sealed by the gasket (11).

[0061] The tub (100) may be suspended from an upper side of the casing (10) by a spring (40), and may be supported at a lower side of the casing (10) by a damper (45). During operation of the clothing treatment apparatus (1), vibration of the tub (100) may be alleviated by the spring (40) and the damper (45).

[0062] The clothing treatment apparatus (1) may be provided with a door (20) that opens and closes the inlet of the casing (10). The door (20) may be hinge-coupled to the casing (10).

[0063] The clothing treatment apparatus (1) according to one embodiment of the present disclosure may include an adjacent component (30). The adjacent component (30) described in one embodiment of the present disclosure may

be a component provided adjacent to the induction module (300) of the clothing treatment apparatus (1).

[0064] In designing and manufacturing the clothing treatment apparatus (1) according to one embodiment of the present disclosure, the induction module (300) and the adjacent component (30) may both be provided at an upper portion of the clothing treatment apparatus (1), while the induction module (300) is located generally at a central portion and the adjacent component (30) is provided to the left or right of the center. In this case, when the induction module (300) and the adjacent component (30) have predetermined sizes, the clothing treatment apparatus (1) should be designed and manufactured so that the induction module (300) and the adjacent component (30) do not interfere with each other.

[0065] This is merely one example, and various design and manufacturing situations may occur in which, in the clothing treatment apparatus (1), the induction module (300) cannot be provided exactly above the center of the tub (100) and the drum (200). Even when such a situation occurs, the clothing treatment apparatus (1) according to one embodiment of the present disclosure allows a magnetic field generated by the induction module (300) to be concentrated generally toward the drum (200), and also prevents noise from the working coil (310) from increasing on either lateral side. A more detailed description thereof will be provided below.

[0066] In one embodiment of the present disclosure, the adjacent component (30) may be a dispenser.

[0067] In the clothing treatment apparatus (1), the dispenser may be provided to supply additives such as laundry detergent, fabric softener, or bleach to the tub (100). When the adjacent component (30) is a dispenser, the dispenser may include a detergent box in which an additive is contained, and a dispenser housing in which the detergent box is withdrawably received.

[0068] The drum (200) is rotatably disposed inside the tub (100). The drum (200) is provided with a space (210) for accommodating laundry and the like therein. The drum (200) may have a generally cylindrical shape.

[0069] The drum (200) comprises a metal material. The drum (200) may be made of a metal material. The drum (200) is made of a material that is heated in a non-contact manner by the induction module (300). That is, the drum (200) is made of a material in which current is induced by a magnetic field (or magnetic force) of the working coil (310) of the induction module (300). The drum (200) may include iron. The drum (200) may be made of stainless steel.

[0070] In the clothing treatment apparatus (1) according to one embodiment of the present disclosure, the drum (200) may be configured as a front-loading type that rotates about a (generally) horizontal axis (a rotation axis (a1)). However, the present disclosure is not limited thereto, and in the case of a top-loading type, the drum (200) may be configured to rotate about a (generally) vertical axis.

[0071] The drum (200) is rotated by a driving unit (50). The driving unit (50) may include a motor capable of controlling a rotation direction and speed. The motor may be a brushless direct current (BLDC) electric motor.

[0072] The induction module (300) according to one embodiment of the present disclosure includes an induction heater. The induction heater is a heater using an induced current generated by a magnetic field as a heat source. When the drum (200) (metal) is located within a magnetic field generated by the induction module (300) (induction heater), an eddy current is generated in the drum (200) by electromagnetic induction, and the drum (200) may be heated by Joule heat.

[0073] The induction module (300) is fixed to the tub (100) in a state of being spaced apart from the drum (200). When the induction module (300) is operated, the drum (200), which is made of a metal material, is heated. The tub (100) is made of a material (for example, synthetic resin) through which a magnetic field may pass, and the induction module (300) is disposed outside the tub (100).

[0074] Depending on the embodiment, the induction module (300) may be disposed inside the tub (100).

[0075] The induction module (300) may be fixedly installed on an outer surface of the tub (100), and the drum (200) inside the tub (100) may be heated by operation of the induction module (300). When the drum (200) rotates inside the tub (100), the drum (200) may be uniformly heated along an entire circumferential direction thereof by the induction module (300).

[0076] The drum (200) is provided inside the tub (100) so as to be rotatable about a rotation axis (a1) extending in a first direction (X). The drum (200) may have a cylindrical shape centered about the rotation axis (a1) extending in the first direction (X).

[0077] In one embodiment of the present disclosure, the first direction (X) may be a direction generally parallel to a horizontal direction. The first direction (X) may be completely parallel to the horizontal direction, or may be inclined at a predetermined angle with respect to the horizontal direction. The first direction (X) may be parallel to a front-rear direction or may be inclined by 15° or less with respect to the front-rear direction.

[0078] The first direction (X), a second direction (Y), and a third direction (Z) described in embodiments of the present disclosure may be directions orthogonal to one another.

[0079] The first direction (X) and the second direction (Y) may each be a direction generally parallel to a horizontal direction, and the third direction (Z) may be a direction generally parallel to a vertical direction. The first direction (X) may be a direction generally parallel to a front-rear direction, the second direction (Y) may be a direction generally parallel to a left-right direction, and the third direction (Z) may be a direction generally parallel to an up-down direction.

[0080] FIG. 4 is an exploded view illustrating some components of the induction module (300) according to one embodiment of the present disclosure.

[0081] FIG. 5 is a view illustrating an arrangement of the drum (200) and the induction module (300) in the clothing treatment apparatus (1) according to one embodiment of the present disclosure.

[0082] The induction module (300) includes the working coil (310) and a plurality of permanent magnets (320). The induction module (300) may include a base housing (330) and a magnet base (340).

[0083] The working coil (310) is configured so that current is applied thereto.

[0084] The working coil (310) may have a form in which an electric wire is wound about a center axis (a2) passing through the center of the working coil (310). At this time, the entire electric wire forming the working coil (310) may be wound so as to lie on a single plane or curved surface, thereby forming the working coil (310). Also, at this time, the surface formed by the working coil (310) may be parallel to an outer circumferential surface of the drum (200). That is, the working coil (310) may be formed along a surface concentric with the drum (200).

[0085] The overall wound shape of the working coil (310) may be circular, elliptical, track-shaped, or the like, or may have a generally rectangular shape as illustrated in FIGS. 4 and 5.

[0086] The working coil (310) may have a length (width) in the first direction (X) that is longer (greater) than a length (width) in the first rotation direction (R1). In addition, the induction module (300) may have a length (width) in the first direction (X) that is longer (greater) than a length (width) in the first rotation direction (R1).

[0087] Heating performance of the drum (200) by the working coil (310) may vary depending on the number of turns of the working coil (310), a spacing between the working coil (310) and the drum (200), an arrangement of the permanent magnets (320), and the like.

[0088] The plurality of permanent magnets (320) may be disposed close to an outer side of the working coil (310), and may serve to concentrate the magnetic field generated by the working coil (310) toward the drum (200).

[0089] When the permanent magnets (320) are coupled to one side (for example, an outer side) of the working coil (310), the permanent magnets (320) may serve to shield part of the magnetic field leaking toward the side to which the permanent magnets (320) are coupled. In the clothing treatment apparatus (1) according to one embodiment of the present disclosure, in order to effectively heat the drum (200), the permanent magnets (320) are disposed adjacent to an outer side of the working coil (310), and when the induction module (300) is provided above the drum (200), the permanent magnets (320) are coupled adjacent to an upper surface of the working coil (310).

[0090] The permanent magnets (320) are coupled on a side of the working coil (310) opposite the drum (200). Accordingly, the permanent magnets (320) may shield a magnetic field leaking outward from the drum (200), and the drum (200) may be effectively heated.

[0091] In one embodiment of the present disclosure, the permanent magnets (320) are ferromagnetic bodies. The permanent magnets (320) may include ferrite. The permanent magnets (320) may be made of ferrite. Since the magnetic field of the working coil (310) cannot induce current in the permanent magnets (320), which are ferromagnetic bodies, current may be intensively induced in the drum (200) located on an inner side (lower side) relative to the working coil (310), and the drum (200) may be effectively heated.

[0092] If the permanent magnets (320) are installed to shield the entire outer side of the working coil (310), the magnetic field leaking outward may be shielded more effectively. However, in such a case, issues such as an increase in material cost may occur. Therefore, the clothing treatment apparatus (1) according to one embodiment of the present disclosure is configured to effectively prevent leakage of the magnetic field while minimizing an increase in the number or quantity of the permanent magnets (320).

[0093] The permanent magnets (320) may be arranged perpendicular to a winding direction of the working coil (310). That is, the permanent magnets (320) may be arranged such that a longitudinal direction of the permanent magnets (320) is orthogonal to a direction of the electric wire of each portion of the working coil (310).

[0094] When current is applied to the working coil (310), a magnetic field is formed according to Ampère's law. The formed magnetic field tends to extend in a direction generally perpendicular to a longitudinal direction of the drum (200). At this time, the direction of the magnetic field may be changed by the permanent magnets (320) of the induction module (300) mounted to the tub (100).

[0095] When the permanent magnets (320) are located adjacent to an outer side of the working coil (310), the magnetic field formed by the working coil (310) may be affected by the magnetic force of the permanent magnets (320). A direction in which the magnetic field changes may vary depending on the direction of lines of magnetic force of the permanent magnets (320).

[0096] In order to concentrate the magnetic field of the working coil (310) toward the drum (200), it is preferable that the permanent magnets (320) be arranged perpendicular to the longitudinal direction of each electric wire of the working coil (310).

[0097] Each permanent magnet (320) may be provided as a bar magnet having the same size. This is because, if the permanent magnets (320) each have different sizes, it may be difficult to uniformly heat the circumferential surface of the drum (200) due to differences in magnetic force.

[0098] The permanent magnets (320) may be disposed to be spaced apart from one another by a predetermined distance along the winding direction of the working coil (310). The permanent magnets (320) may be distributed and disposed in all directions, namely front, rear, left, and right, along the winding direction of the working coil (310). When the permanent magnets (320) are disposed only at a specific position of the working coil (310), the amount of the magnetic field radiated toward the drum (200) may differ for each portion of the outer circumference of the drum (200), and uniform heating may therefore be difficult.

[0099] A length of the permanent magnet (320) may be formed to be the same as a width of the working coil (310) (a spacing between an innermost electric wire and an outermost electric wire of the wound working coil (310)). At this time, with respect to a center (301) of the induction module (300), an outer end of the permanent magnet (320) may be located directly above the outermost electric wire of the working coil (310), and an inner end of the permanent magnet (320) may be located directly above the innermost electric wire of the working coil (310). Accordingly, efficient use of the permanent magnets (320) and improvement in heating performance of the drum (200) by the working coil (310) may be achieved.

[0100] The base housing (330) is configured to accommodate the working coil (310) and is fixedly coupled to the tub (100).

[0101] An accommodating groove (331) corresponding to the wound shape of the working coil (310) is formed in the base housing (330), and the base housing (330) is fixed to an outer surface of the tub (100) through fixing means (bolts, rivets, etc.).

[0102] The magnet base (340) is fixedly coupled to an outer side of the base housing (330). A plurality of support grooves (341) are formed in the magnet base (340). Each support groove (341) may correspond to the size and shape of each permanent magnet (320).

[0103] The base housing (330) and the magnet base (340) may be made of plastic.

[0104] An induction cover (350) that shields the permanent magnets (320) and is fixedly coupled to the magnet base (340) may be coupled to an outer side of the magnet base (340).

[0105] In one embodiment of the present disclosure, the induction module (300) may be arranged such that a center of the induction module (300) is located on a second reference plane (RS2) that forms, with a first reference plane (RS1) in a vertical direction (gravity direction) passing through the rotation axis (a1) of the drum (200), a predetermined angle (θ) about the rotation axis (a1) in a first rotation direction (R1).

[0106] The first rotation direction (R1) may be a rotation direction of the drum (200).

[0107] The first reference plane (RS1) is a virtual plane in the vertical direction.

[0108] The first reference plane (RS1) is a plane passing through the rotation axis (a1). That is, the rotation axis (a1) of the drum (200) is formed on the first reference plane (RS1) and along the first reference plane (RS1).

[0109] When the rotation axis (a1) is formed along the front-rear direction (the first direction (X)), the first reference plane (RS1) is a plane extending along the vertical direction (the third direction (Z)) and parallel to the front-rear direction (the first direction (X)).

[0110] The second reference plane (RS2) is a virtual plane rotated by a predetermined angle (θ) from the first reference plane (RS1) about the rotation axis (a1) in the first rotation direction (R1). The first rotation direction (R1) may be a clockwise direction about the rotation axis (a1), or may be a counterclockwise direction.

[0111] When the rotation axis (a1) is formed along the front-rear direction (the first direction (X)), the first reference plane (RS1) is a plane perpendicular to the ground on which the clothing treatment apparatus (1) is placed, and the second reference plane (RS2) is a plane inclined with respect to the ground.

[0112] The angle (θ) by which the second reference plane (RS2) is rotated with respect to the first reference plane (RS1) may be any angle from 3° to 20°. The angle (θ) by which the second reference plane (RS2) is rotated with respect to the first reference plane (RS1) may be any angle from 5° to 15°.

[0113] In one embodiment of the present disclosure, the induction module (300) is configured such that the center (301) of the induction module (300) is located on the second reference plane (RS2). As illustrated in FIG. 2, the induction module (300) may be located not exactly at the upper center of the drum (200), but at a position rotated clockwise by a predetermined angle (θ). At this time, the working coil (310) of the induction module (300) is positioned so as to be inclined toward one side (the right side based on FIG. 2).

[0114] The working coil (310) is arranged such that the center of the working coil (310) is located on the second reference plane (RS2).

[0115] The working coil (310) may be divided into a first coil portion (311) and a second coil portion (312).

[0116] The first coil portion (311) is a half of the working coil (310) located, with respect to the second reference plane (RS2), on a side toward the first rotation direction (R1).

[0117] The second coil portion (312) is a half of the working coil (310) located, with respect to the second reference plane (RS2), on a side toward a direction opposite to the first rotation direction (R1).

[0118] As described above, in order to avoid interference with the adjacent component (30) while the induction module (300) has a predetermined size in the clothing treatment apparatus (1), the induction module (300) may be

configured such that the center (301) of the induction module (300) is located not on the first reference plane (RS1), but on the second reference plane (RS2).

[0119] Apart from this, the center (301) of the induction module (300) may be located on the second reference plane (RS2) for various design reasons in the clothing treatment apparatus (1).

[0120] In the clothing treatment apparatus (1) according to one embodiment of the present disclosure, the center of the working coil (310) may be the same point as the center (301) of the induction module (300).

[0121] In the clothing treatment apparatus (1) according to one embodiment of the present disclosure, the length of the working coil (310) in the first rotation direction (R1) may be shorter than the length thereof in the first direction (X).

[0122] In the clothing treatment apparatus (1) according to one embodiment of the present disclosure, the working coil (310) of the induction module (300) may be configured to intersect the first reference plane (RS1). At this time, the second coil portion (312) of the working coil (310) intersects the first reference plane (RS1). Even when the induction module (300) is located at a position rotated by a predetermined angle (θ) from the upper center of the drum (200), the working coil (310) may be configured to still extend across the upper center position of the drum (200). Accordingly, left-right imbalance of noise caused by the working coil (310) of the induction module (300) may be minimized.

[0123] In the induction module (300), the permanent magnets (320) may be divided into a first group (320a) and a second group (320b). The first group (320a) and the second group (320b) are each a combination of one or more permanent magnets (320) among the plurality of permanent magnets (320) constituting the induction module (300), and the permanent magnets (320) of the first group (320a) and the permanent magnets (320) of the second group (320b) are distinct from each other.

[0124] The first group (320a) is a combination of one or more permanent magnets (320) disposed in a first region (t1) located, with respect to the second reference plane (RS2), on a side toward the first rotation direction (R1), and the second group (320b) is a combination of one or more permanent magnets (320) disposed in a second region (t2) located, with respect to the second reference plane (RS2), on a side toward a direction opposite to the first rotation direction (R1).

[0125] The first group (320a) is disposed on an outer side of the first coil portion (311), and is configured to shield a portion of the first coil portion (311).

[0126] The second group (320b) is disposed on an outer side of the second coil portion (312), and is configured to shield a portion of the second coil portion (312).

[0127] When the first direction (X) is the front-rear direction and the first rotation direction (R1) is the clockwise direction, as viewed from above, the first region (t1) is a portion of the induction module (300) on the right side of the second reference plane (RS2), and the second region (t2) is a portion of the induction module (300) on the left side of the second reference plane (RS2).

[0128] In one embodiment of the present disclosure, the induction module (300) is biased toward one side and inclined with respect to the first reference plane (RS1). At this time, the first region (t1) is a region relatively farther from the first reference plane (RS1), and the second region (t2) is a region relatively closer to the first reference plane (RS1).

[0129] In one embodiment of the present disclosure, the magnetic force of the second group (320b) is greater than the magnetic force of the first group (320a).

[0130] In one embodiment of the present disclosure, an area of the second coil portion (312) shielded by the permanent magnets (320) may be greater than an area of the first coil portion (311) shielded by the permanent magnets (320). The area of the first coil portion (311) shielded by the permanent magnets (320) is an area of the first coil portion (311) covered by the permanent magnets (320) when viewed from a radially outer side with respect to the rotation axis (a1). The area of the second coil portion (312) shielded by the permanent magnets (320) is an area of the second coil portion (312) covered by the permanent magnets (320) when viewed from a radially outer side with respect to the rotation axis (a1).

[0131] In one embodiment of the present disclosure, the permanent magnets (320) of the induction module (300) may be variously configured within a range in which the magnetic force of the second group (320b) is greater than the magnetic force of the first group (320a). In one embodiment, magnets having relatively large magnetic force may be disposed in the second group (320b), and magnets having relatively small magnetic force may be disposed in the first group (320a).

[0132] In the clothing treatment apparatus (1) according to one embodiment of the present disclosure, when the plurality of permanent magnets (320) of the induction module (300) are identical to one another, the number of permanent magnets (320) in the second group (320b) may be greater than the number of permanent magnets (320) in the first group (320a).

[0133] In the clothing treatment apparatus (1) according to one embodiment of the present disclosure, the plurality of permanent magnets (320) may all be identical to one another, and the number of permanent magnets (320) provided on an outer side of the second coil portion (312) may be greater than the number of permanent magnets (320) provided on an outer side of the first coil portion (311).

[0134] Accordingly, the issue of radiated noise may be solved simply and easily.

[0135] When the plurality of permanent magnets (320) of the induction module (300) are identical to one another, the combination of the number of permanent magnets (320) in the first group (320a) and the number of permanent magnets (320) in the second group (320b) may be, for example, (6, 7), (6, 8), (6, 9), (7, 9), (8, 9), or the like.

[0136] As described above, the working coil (310) may be wound around the center axis (a2) passing through the center (301) of the induction module (300).

[0137] Here, the center axis (a2) of the induction module (300) is a line that lies in the second reference plane (RS2). The center axis (a2) of the induction module (300) is a line formed in the second reference plane (RS2) so as to extend along the second reference plane (RS2), and is orthogonal to the rotation axis (a1).

[0138] In the induction module (300), the plurality of permanent magnets (320) may be disposed within a region formed by the working coil (310). The region formed by the working coil (310) may be a space defined by the outermost electric wire of the working coil (310), and may be a space defined between the outermost electric wire and the innermost electric wire of the working coil (310).

[0139] In one embodiment of the present disclosure, the plurality of permanent magnets (320) provided in the induction module (300) may be arranged symmetrically with respect to a third reference plane (RS3).

[0140] The third reference plane (RS3) is a virtual plane that is perpendicular to the first reference plane (RS1) and passes through the center axis (a2).

[0141] When the first direction (X) is a direction parallel to the front-rear direction, the first reference plane (RS1) and the third reference plane (RS3) may both be vertical planes. However, the first reference plane (RS1) is parallel to the front-rear direction and the third reference plane (RS3) is parallel to the left-right direction.

[0142] Since the plurality of permanent magnets (320) are provided symmetrically with respect to the third reference plane (RS3), uniform heating may be performed at front and rear sides in the axial direction of the drum (200).

[0143] FIG. 6 is a view illustrating, by simulation, a state in which a magnetic field acts when a drum (200) and a working coil (310) according to one embodiment of the present disclosure are provided and a permanent magnet (M) is provided on an outer side of the working coil (310). FIG. 6 is illustrated in a cross-sectional form, and FIG. 6 assumes that the drum (200) rotates clockwise.

[0144] FIG. 7A is a view illustrating, by simulation, a state in which a magnetic field acts when no permanent magnet is provided and the drum (200) and the working coil (310) are provided as in FIG. 6.

[0145] FIG. 7B is a view illustrating, by simulation, a state in which a magnetic field acts when the drum (200) and the working coil (310) are provided as in FIG. 6 and permanent magnets are provided on left and right outer sides of the working coil (310).

[0146] FIG. 7C is a view illustrating, by simulation, a state in which a magnetic field acts when the drum (200) and the working coil (310) are provided as in FIG. 6 and a permanent magnet is provided only on a left outer side of the working coil (310).

[0147] FIG. 8 is a view illustrating, by simulation, a state in which a magnetic field acts when the drum (200) and the working coil (310) are provided as in FIG. 6, permanent magnets are provided on left and right outer sides of the working coil (310), and the magnetic force of the permanent magnet on the left side is smaller than the magnetic force of the permanent magnet on the right side.

[0148] FIG. 9A is a view illustrating, by simulation, a state in which a magnetic field acts when the drum (200) and the working coil (310) are provided as in FIG. 6, permanent magnets are provided on left and right outer sides of the working coil (310), and the magnetic force of the permanent magnet on the left side is greater than the magnetic force of the permanent magnet on the right side.

[0149] FIG. 9B is a view illustrating, by simulation, a state in which a magnetic field acts when the drum (200), the working coil (310), and permanent magnets are provided as in FIG. 9A, and the magnetic force of the permanent magnet on the left side is greater than the magnetic force of the permanent magnet on the left side in FIG. 9A.

[0150] FIG. 9C is a view illustrating, by simulation, a state in which a magnetic field acts when the drum (200), the working coil (310), and permanent magnets are provided as in FIG. 9B, and the magnetic force of the permanent magnet on the left side is greater than the magnetic force of the permanent magnet on the left side in FIG. 9B.

[0151] In each of FIGS. 7A to 9C, the working coil (310) is disposed at the same position as in FIG. 6.

[0152] In each of FIGS. 7A to 9C, magnetic flux lines (FL) are shown around the working coil (310), and changes in magnetic flux density (MD) are shown by differences in shading. The magnetic flux density (MD) is highest at a portion adjacent to the working coil (310), and the magnetic flux density (MD) decreases toward the outer side.

[0153] In each of FIGS. 7A to 9C, a lower inner portion and a lower portion of the drum (200) are shown in a dark color. This dark coloring is due to the distribution results for the magnetic flux density (MD) in each of FIGS. 7A to 9C being represented as black-and-white images. As mentioned above, the magnetic flux density (MD) decreases toward the outer side of the working coil (310).

[0154] FIG. 10 is a view schematically illustrating arrangements of permanent magnets (320) in the induction module (300).

[0155] FIG. 11 is a view illustrating a ratio of the number of second magnets (322) to the number of first magnets (321) according to an inclination angle of the induction module (300).

[0156] FIG. 12 is a view schematically illustrating a state in which noise of the clothing treatment apparatus (1) according to one embodiment of the present disclosure is measured.

[0157] As illustrated in FIG. 6, the working coil (310) is disposed on an outer side of the drum (200). At this time, the working coil (310) is arranged such that the center of the working coil (310) is located on the second reference plane (RS2) that forms a predetermined angle with the first reference plane (RS1). As the working coil (310) is wound with respect to the center (301) of the induction module (300), a right portion of the working coil (310), which is the first coil portion (311), and a left portion of the working coil (310), which is the second coil portion (312), are located on both sides with respect to the second reference plane (RS2).

[0158] Magnetic flux inside the drum (200) is affected by the rotation direction of the drum (200), and when the magnetic flux lines acting inside the drum (200) in FIG. 6 are observed, it can be seen that the magnetic flux at point A and the magnetic flux at point B have different forms.

[0159] When the permanent magnet (M) is provided on an outer side of the second coil portion (312) on the left side of the working coil (310), it can be seen that the magnetic flux outside the permanent magnet (M) (point C) is reduced, and accordingly it can be seen that the magnetic field may be concentrated toward the drum (200).

[0160] As illustrated in FIG. 7A, when no permanent magnet is provided and the working coil (310) is provided above the drum (200) so as to be biased and inclined to the right side, a line segment (L1) connecting corresponding left and right magnetic flux lines is inclined downward to the right, and a line segment (L2) connecting a left-side point and a corresponding right-side point in the magnetic flux density is inclined downward to the right.

[0161] As illustrated in FIG. 7B, when permanent magnets are provided on outer sides of both the second coil portion (312) on the left side and the first coil portion (311) on the right side of the working coil (310), as compared with FIG. 7A, it can be seen that the radius of the magnetic flux lines is reduced, the line segment (L3) connecting corresponding left and right magnetic flux lines has moved downward relative to the line segment (L1), and the line segment (L4) connecting a left-side point and a corresponding right-side point in the magnetic flux density has also moved downward relative to the line segment (L2).

[0162] That is, as in the case of FIG. 7B, when permanent magnets are respectively provided on outer sides of both the second coil portion (312) on the left side and the first coil portion (311) on the right side of the working coil (310), it can be seen that radiation of the magnetic field outward may be blocked as compared with the case of FIG. 7A.

[0163] Further, in the case of FIG. 7B, when the magnetic flux line (FL2) formed below the drum (200) is compared with the magnetic flux line (FL1) formed below the drum (200) in the case of FIG. 7A, it can be seen that the radius of the magnetic flux line (FL) is reduced.

[0164] As illustrated in FIG. 7C, when a permanent magnet is provided only on an outer side of the second coil portion (312) on the left side of the working coil (310), as compared with FIG. 7A, it can be seen that the line segment (L5) connecting corresponding left and right magnetic flux lines has an improved inclination (is closer to horizontal) relative to the line segment (L1), and the line segment (L6) connecting a left-side point and a corresponding right-side point in the magnetic flux density also has an improved inclination (is closer to horizontal) relative to the line segment (L2). That is, it can be seen that left-right imbalance of the magnetic field may be resolved.

[0165] Further, in the case of FIG. 7C, when the magnetic flux line (FL3) formed below the drum (200) is compared with the magnetic flux line (FL1) formed below the drum (200) in the case of FIG. 7A, it can be seen that the radius of the magnetic flux line (FL) is further reduced.

[0166] As illustrated in FIG. 8, when permanent magnets are provided on outer sides of the second coil portion (312) on the left side and the first coil portion (311) on the right side of the working coil (310), and the magnetic force of the permanent magnet on the left side is smaller than the magnetic force of the permanent magnet on the right side, it can be seen that the line segment (L7) connecting corresponding left and right magnetic flux lines has a worsened inclination (increased) relative to the line segment (L1), and that the line segment (L8) connecting a left-side point and a corresponding right-side point in the magnetic flux density also has a worsened inclination (increased) relative to the line segment (L2). That is, it can be seen that left-right imbalance of the magnetic field becomes more severe.

[0167] Further, in the case of FIG. 8, when the magnetic flux line (FL4) formed below the drum (200) is compared with the magnetic flux line (FL2) formed below the drum (200) in the case of FIG. 7B, it can be seen that the radius of the magnetic flux line (FL) is further increased.

[0168] As illustrated in FIG. 9A, when permanent magnets are provided on outer sides of the second coil portion (312) on the left side and the first coil portion (311) on the right side of the working coil (310), and the magnetic force of the permanent magnet on the left side is greater than the magnetic force of the permanent magnet on the right side, it can be seen that the line segment (L9) connecting corresponding left and right magnetic flux lines has an improved inclination (is closer to horizontal) relative to the line segment (L1), and that the line segment (L10) connecting a left-side point and a corresponding right-side point in the magnetic flux density also has a further improved inclination (is closer to horizontal) relative to the line segment (L2).

[0169] In addition, it can be seen that the case of FIG. 9B is further improved compared with the case of FIG. 9A, and that the case of FIG. 9C is further improved compared with the case of FIG. 9B.

[0170] When the magnetic flux line (FL5) formed below the drum (200) in the case of FIG. 9A, the magnetic flux line (FL6) formed below the drum (200) in the case of FIG. 9B, and the magnetic flux line (FL7) formed below the drum (200) in the case of FIG. 9C are each compared with the magnetic flux line (FL2) formed below the drum (200) in the case of FIG. 7B, it can be seen that the radius of the magnetic flux line (FL) gradually decreases.

[0171] In the clothing treatment apparatus (1) according to one embodiment of the present disclosure, the permanent magnets (320) of the induction module (300) are configured in consideration of these points.

[0172] In one embodiment of the present disclosure, the plurality of permanent magnets (320) of the induction module (300) may include first magnets (321) and second magnets (322).

[0173] The first magnets (321) are one or more permanent magnets (320) belonging to the first group (320a) and parallel to the third reference plane (RS3).

[0174] The second magnets (322) are one or more permanent magnets (320) belonging to the second group (320b) and parallel to the third reference plane (RS3).

[0175] The first magnets (321) and the second magnets (322) may be identical to one another.

[0176] In one embodiment of the present disclosure, a ratio of a number of the second magnets (322) to a number of the first magnets (321) may range from 2 to 4.

[0177] In one embodiment of the present disclosure, the plurality of permanent magnets (320) of the induction module (300) may include third magnets (323) and fourth magnets (324).

[0178] The third magnets (323) are magnets disposed on one side with respect to the third reference plane (RS3), and the fourth magnets (324) are magnets disposed on an opposite side from the third magnets (323) with respect to the third reference plane (RS3).

[0179] In one embodiment of the present disclosure, the angle (deg) between the first reference plane (RS1) and the second reference plane (RS2) may range from 5° to 15°.

[0180] In one embodiment of the present disclosure, the angle (deg) between the first reference plane (RS1) and the second reference plane (RS2) may be 5°, and the ratio of the number of the second magnets (322) to the number of the first magnets (321) may be 2.5. In one embodiment of the present disclosure, the angle (deg) between the first reference plane (RS1) and the second reference plane (RS2) may be 10°, and the ratio of the number of the second magnets (322) to the number of the first magnets (321) may be 3. In one embodiment of the present disclosure, the angle (deg) between the first reference plane (RS1) and the second reference plane (RS2) may be 15°, and the ratio of the number of the second magnets (322) to the number of the first magnets (321) may be 3.5.

[0181] The clothing treatment apparatus (1) according to one embodiment of the present disclosure may be configured such that, when a value of the angle (deg) between the first reference plane (RS1) and the second reference plane (RS2) is plotted on an x-axis and a value of the ratio of the number of the second magnets (322) to the number of the first magnets (321) is plotted on a y-axis, a point defined by the value of the angle (deg) and the value of the ratio lies on a graph passing through (10, 3) and having a slope of 1/10.

[0182] As illustrated in FIG. 12, an antenna (2) may be positioned at one side of the clothing treatment apparatus (1), and peak noise radiated from the clothing treatment apparatus (1) may be measured while the clothing treatment apparatus (1) is rotated about a vertical rotation axis (a3).

[0183] Table 1 below shows result values obtained by measuring radiated noise when, in the clothing treatment apparatus (1) according to one embodiment of the present disclosure, the permanent magnets (320) of the induction module (300) are arranged as illustrated in (a) to (g) of FIG. 10, and when the induction module (300) is arranged to be inclined such that the center (301) of the induction module (300) is located on the second reference plane (RS2), as illustrated in FIGS. 2 and 5. The result values in each of the cases of (a) to (g) of FIG. 10 correspond to the values of (a) to (g), respectively, in Table 1.

[Table 1]

Number and arrangement of permanent magnets	First measurement value [dB]	Second measurement value [dB]
(a)	64.5	71.7
(b)	60.4	70.4
(c)	61.4	66.4
(d)	65.7	65.8
(e)	58.8	67.1
(f)	58.2	70.2

(continued)

Number and arrangement of permanent magnets	First measurement value [dB]	Second measurement value [dB]
(g)	65.6	71.4

[0184] In each of (a) to (g) of FIG. 10, the permanent magnets (320) are all identical to one another. In each of (a) to (g) of FIG. 10, when the number (n1) of first magnets (321) and the number (n2) of second magnets (322) are represented as (n1, n2), the case of (a) of FIG. 10 is (2, 2), the case of (b) of FIG. 10 is (2, 3), the case of (c) of FIG. 10 is (2, 4), the case of (d) of FIG. 10 is (2, 5), the case of (e) of FIG. 10 is (3, 5), the case of (f) of FIG. 10 is (4, 5), and the case of (g) of FIG. 10 is (5, 5).

[0185] In Table 1 above, the first measurement value is a value measured at a point spaced apart in the rightward direction with respect to each of the drawings of (a) to (g) of FIG. 10 (for example, a value measured at a point spaced apart from the drum (200) and the working coil (310) in the second direction (Y) (for example, spaced apart by 3 m) in FIG. 5), and the second measurement value is a value measured at a point spaced apart in the leftward direction with respect to each of the drawings of (a) to (g) of FIG. 10 (for example, a value measured at a point spaced apart from the drum (200) and the working coil (310) in a direction opposite to the second direction (Y) (for example, spaced apart by 3 m) in FIG. 5).

[0186] In the case of (a) of FIG. 10, the first measurement value (64.5 dB) is equal to or less than a required favorable reference value (for example, 69 dB according to a radiated disturbance test standard). However, the second measurement value (71.7 dB) exceeds the required favorable reference value (for example, 69 dB according to the radiated disturbance test standard), and therefore the second measurement value needs to be reduced.

[0187] As compared with the case of (a) of FIG. 10, it can be seen that (b), (c), (e), and (f) of FIG. 10 are improved in that the first measurement value is reduced, and it can be seen that (b), (c), (d), (e), (f), and (g) of FIG. 10 are all improved in that the second measurement value is reduced.

[0188] As compared with the case of (a) of FIG. 10, in the case of (d) of FIG. 10, the first measurement value slightly increased. However, the first measurement value (65.7 dB) and the second measurement value (65.8 dB) are values close to each other, and thus it can be seen that the imbalance is resolved. The first measurement value (65.7 dB) itself corresponds to a favorable value.

[0189] Therefore, it can be seen that excellent results are obtained when the number (n1) of first magnets (321) and the number (n2) of second magnets (322) are provided as (2, 5), as in the case of (d) of FIG. 10.

[0190] As described above, the induction module (300) includes, with respect to the second reference plane (RS2), the first group (320a), which is a combination of permanent magnets (320) disposed in the first region (t1), and the second group (320b), which is a combination of permanent magnets (320) disposed in the second region (t2), and the magnetic force of the second group (320b) is greater than the magnetic force of the first group (320a). Each permanent magnet (320) allows the magnetic field generated by the working coil (310) to be concentrated toward the drum (200), and even when the induction module (300) is arranged asymmetrically with respect to the first reference plane (RS1), the permanent magnets (320) may alleviate asymmetry in magnetic flux, and allow the magnetic field and the magnetic flux to be concentrated toward the drum (200).

[0191] Further, as described above, when the induction module (300) is arranged to be inclined (lowered) toward one side above the drum (200), an increase in noise in a direction opposite to the inclined (lowered) side may be prevented.

[0192] In addition, in one embodiment of the present disclosure, when the plurality of permanent magnets (320) are all identical to one another, the number of permanent magnets (320) in the second group (320b) is greater than the number of permanent magnets (320) in the first group (320a), and the permanent magnets (320) in the second group (320b) may allow the magnetic field and magnetic flux of the working coil (310) to be concentrated toward the drum (200) to a greater extent than the permanent magnets (320) in the first group (320a), and may prevent noise caused by the magnetic field from increasing on one side.

[0193] In addition, when designing the clothing treatment apparatus (1), a restriction requiring the induction module (300) to be disposed at the exact center vertically above the drum (200) may be avoided, and design freedom of the clothing treatment apparatus (1) may be improved.

[0194] Although specific embodiments of the present disclosure have been described above and illustrated in the figures, the present disclosure is not limited to the described embodiments, and it will be apparent to a person ordinarily skilled in the art that various modifications and changes may be made without departing from the spirit and scope of the present disclosure. Accordingly, such modifications or variations should not be individually understood as departing from the technical spirit or perspective of the present disclosure, and modified embodiments should be regarded as falling within the scope of the claims of the present disclosure.

INDUSTRIAL APPLICABILITY

[0195] The clothing treatment apparatus according to embodiments of the present disclosure has significant industrial applicability in that, even when the induction module is arranged asymmetrically, the clothing treatment apparatus is configured to alleviate asymmetry in magnetic flux and to allow the magnetic field and the magnetic flux to be concentrated toward the drum.

Claims

1. A clothing treatment apparatus comprising:

a tub;

a drum comprising a metal material, provided with a space for accommodating laundry therein, and provided inside the tub so as to be rotatable about a rotation axis extending in a first direction; and an induction module fixedly coupled to the tub, the induction module comprising a working coil configured to heat the drum through a magnetic field when current is applied, and a plurality of permanent magnets provided adjacent to an outer side of the working coil,

wherein the induction module is arranged such that a center of the induction module is located on a second reference plane that forms, with a vertical first reference plane passing through the rotation axis, a predetermined angle about the rotation axis in a first rotation direction, and

wherein the induction module comprises:

a first group that is a combination of one or more of the permanent magnets disposed in a first region that is located, with respect to the second reference plane, on a side toward the first rotation direction; and

a second group that is a combination of one or more of the permanent magnets disposed in a second region that is located, with respect to the second reference plane, on a side toward a direction opposite to the first rotation direction, and

wherein the magnetic force of the second group is greater than the magnetic force of the first group.

2. The clothing treatment apparatus of claim 1, wherein, when the plurality of permanent magnets are identical to one another, the number of permanent magnets in the second group is greater than the number of permanent magnets in the first group.

3. The clothing treatment apparatus of claim 1,

wherein the working coil is wound about a center axis extending along the second reference plane and passing through the center of the induction module, and

wherein the plurality of permanent magnets are arranged to be orthogonal to a direction in which the working coil is wound.

4. The clothing treatment apparatus of claim 3, wherein the plurality of permanent magnets are disposed within a region formed by the working coil.

5. The clothing treatment apparatus of claim 3, wherein the plurality of permanent magnets are arranged symmetrically with respect to a third reference plane that is perpendicular to the first reference plane and passes through the center axis.

6. The clothing treatment apparatus of claim 5, wherein the plurality of permanent magnets comprise:

one or more first magnets belonging to the first group and parallel to the third reference plane; and

one or more second magnets belonging to the second group and parallel to the third reference plane,

wherein the first magnets and the second magnets are identical to one another, and

wherein a ratio of a number of the second magnets to a number of the first magnets ranges from 2 to 4.

7. The clothing treatment apparatus of claim 5, wherein the plurality of permanent magnets comprise:

a third magnet disposed on one side with respect to the third reference plane; and
a fourth magnet disposed on an opposite side from the third magnet with respect to the third reference plane.

8. The clothing treatment apparatus of claim 6, wherein the angle (θ) ranges from 5° to 15°.

9. The clothing treatment apparatus of claim 6, wherein the angle (θ) is 5°, and the ratio is 2.5.

10. The clothing treatment apparatus of claim 6, wherein, when a value of the angle (deg) is plotted on an x-axis and a value of the ratio is plotted on a y-axis, a point defined by the value of the angle (deg) and the value of the ratio lies on a graph passing through (10, 3) and having a slope of 1/10.

11. A clothing treatment apparatus comprising:

a tub;

a drum comprising a metal material, provided with a space for accommodating laundry therein, and provided inside the tub so as to be rotatable about a rotation axis extending in a first direction; and
an induction module fixedly coupled to the tub, the induction module comprising a working coil configured to heat the drum through a magnetic field when current is applied, and a plurality of permanent magnets provided adjacent to an outer side of the working coil,

wherein the working coil is arranged such that a center of the working coil is located on a second reference plane that forms, with a vertical first reference plane passing through the rotation axis, a predetermined angle about the rotation axis in a first rotation direction,
wherein the working coil is divided into:

a first coil portion located, with respect to the second reference plane, on a side toward the first rotation direction; and

a second coil portion located, with respect to the second reference plane, on a side toward a direction opposite to the first rotation direction, and

wherein an area of the second coil portion shielded by the permanent magnets is greater than an area of the first coil portion shielded by the permanent magnets.

12. The clothing treatment apparatus of claim 11,

wherein the plurality of permanent magnets are all identical to one another, and
wherein the number of permanent magnets provided on an outer side of the second coil portion is greater than the number of permanent magnets provided on an outer side of the first coil portion.

13. The clothing treatment apparatus of any one of claims 1 to 12,

wherein the drum has a cylindrical shape centered about the rotation axis, and
wherein the induction module is fixed to an outer surface of the tub.

14. The clothing treatment apparatus of any one of claims 1 to 12,

wherein the first direction is parallel to a front-rear direction or is inclined by 15° or less with respect to the front-rear direction, and
wherein the induction module is located above the drum.

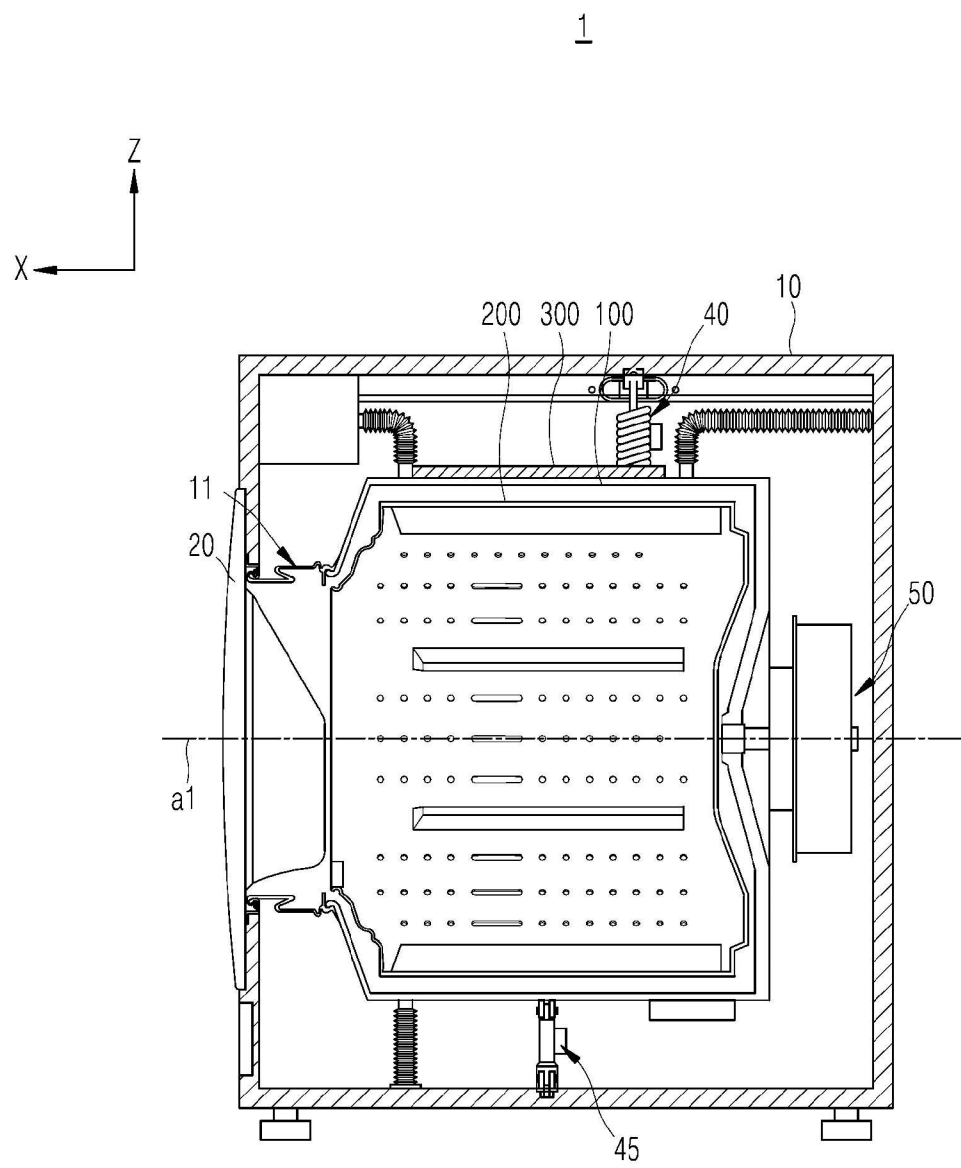
15. The clothing treatment apparatus of claim 14, wherein the working coil intersects the first reference plane.

16. The clothing treatment apparatus of any one of claims 1 to 12, wherein the induction module comprises:

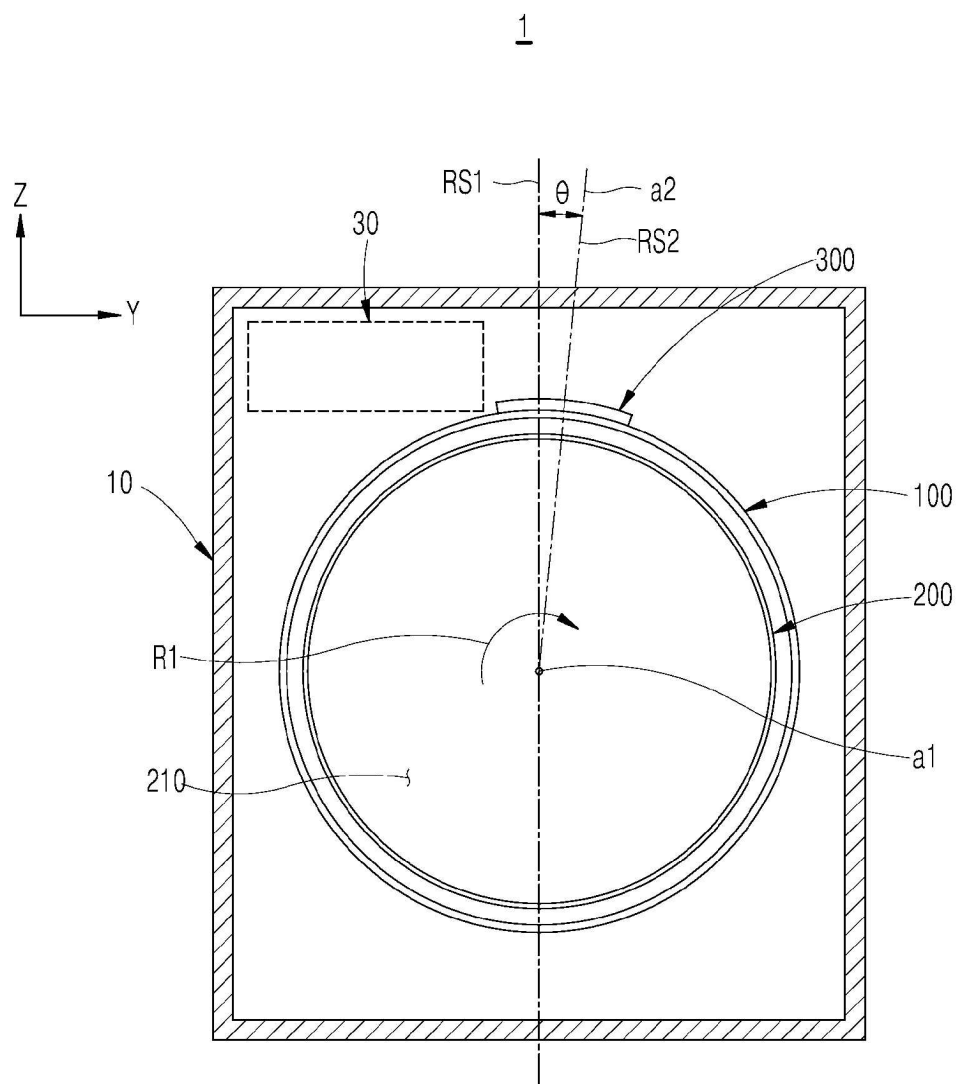
a base housing fixedly coupled to an outer surface of the tub and in which the working coil is accommodated; and

a magnet base having support grooves in which respective ones of the plurality of permanent magnets are accommodated, and fixedly coupled to an outer side of the base housing.

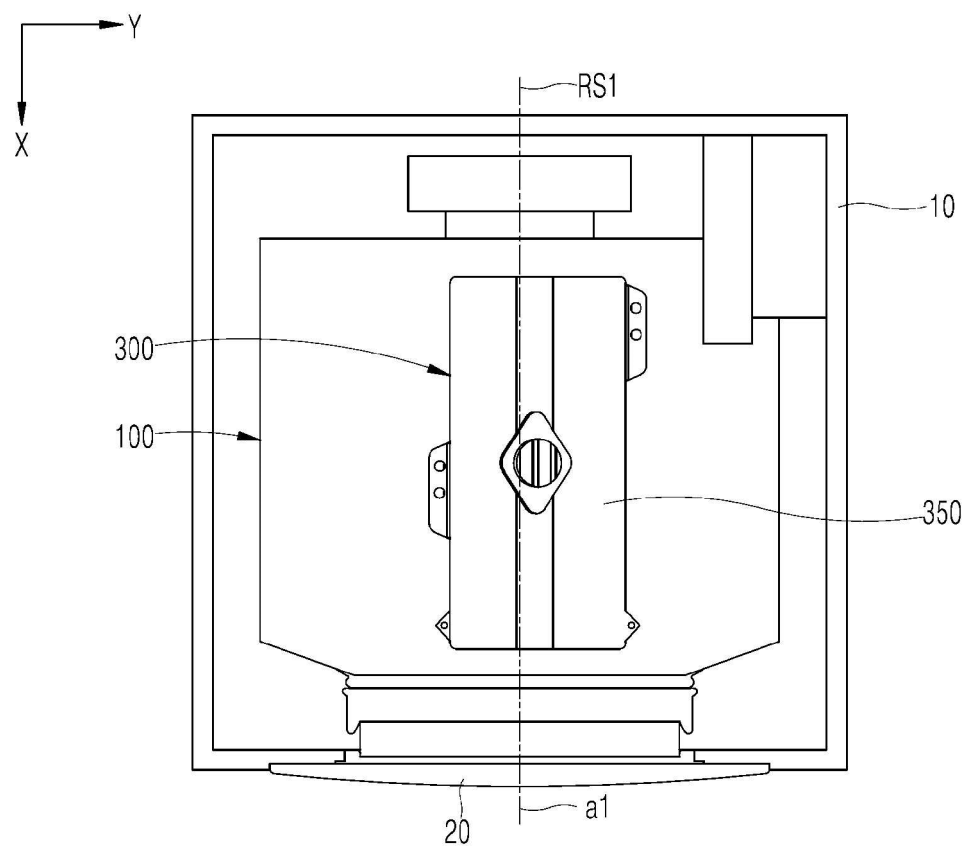
[FIG. 1]



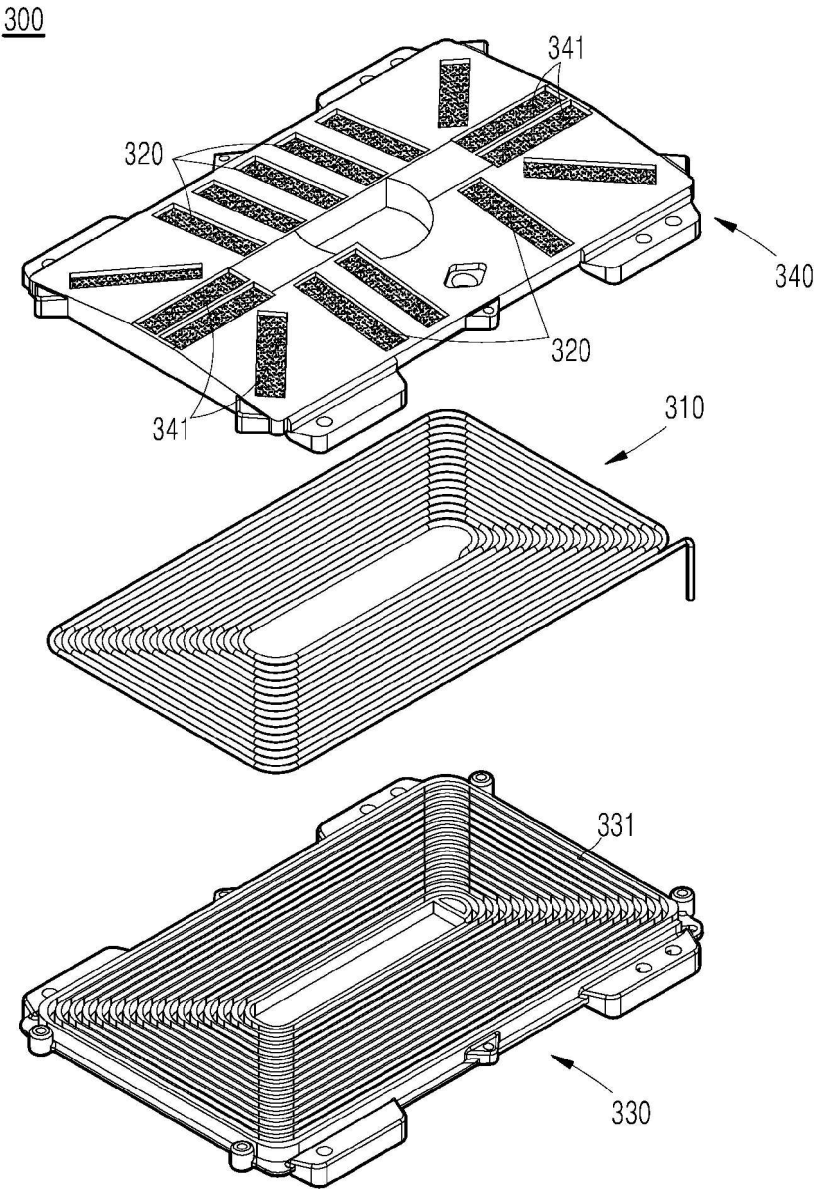
[FIG. 2]



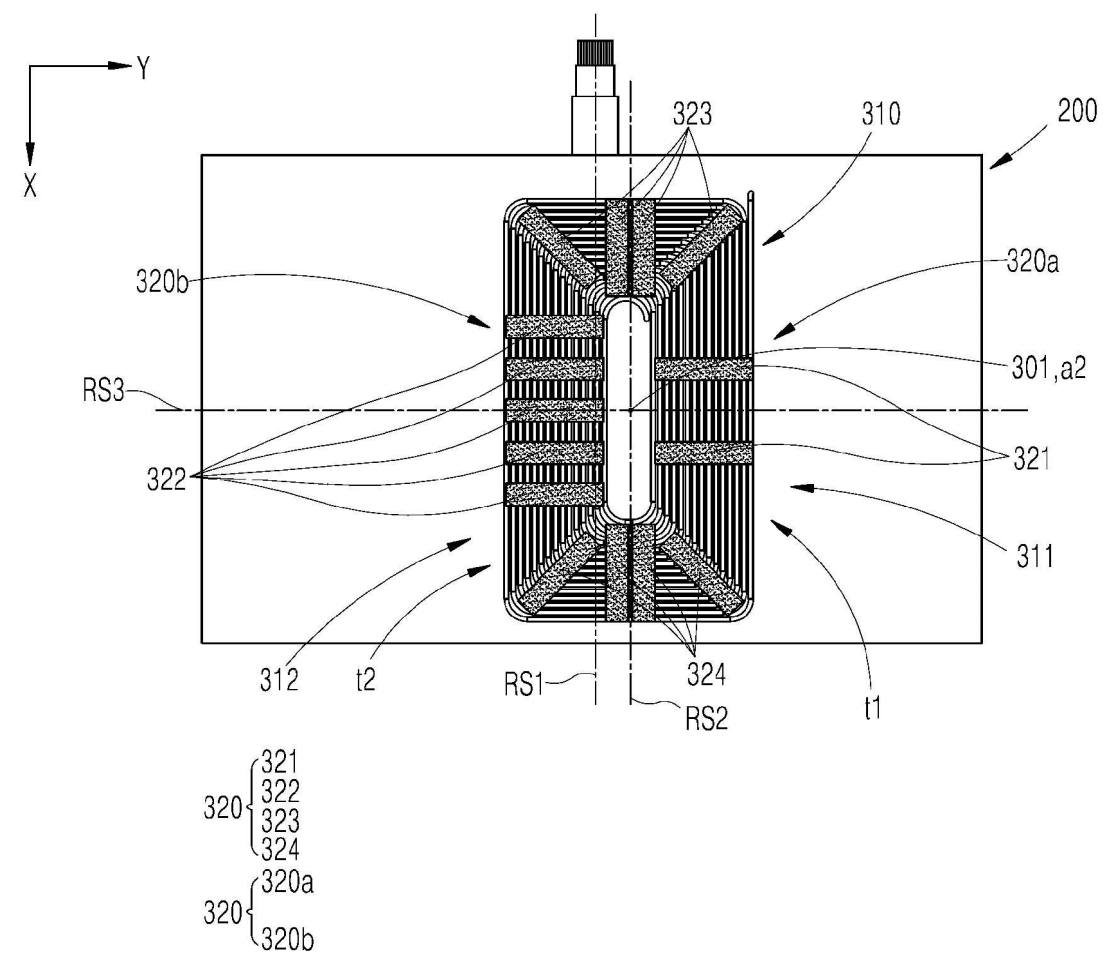
[FIG. 3]



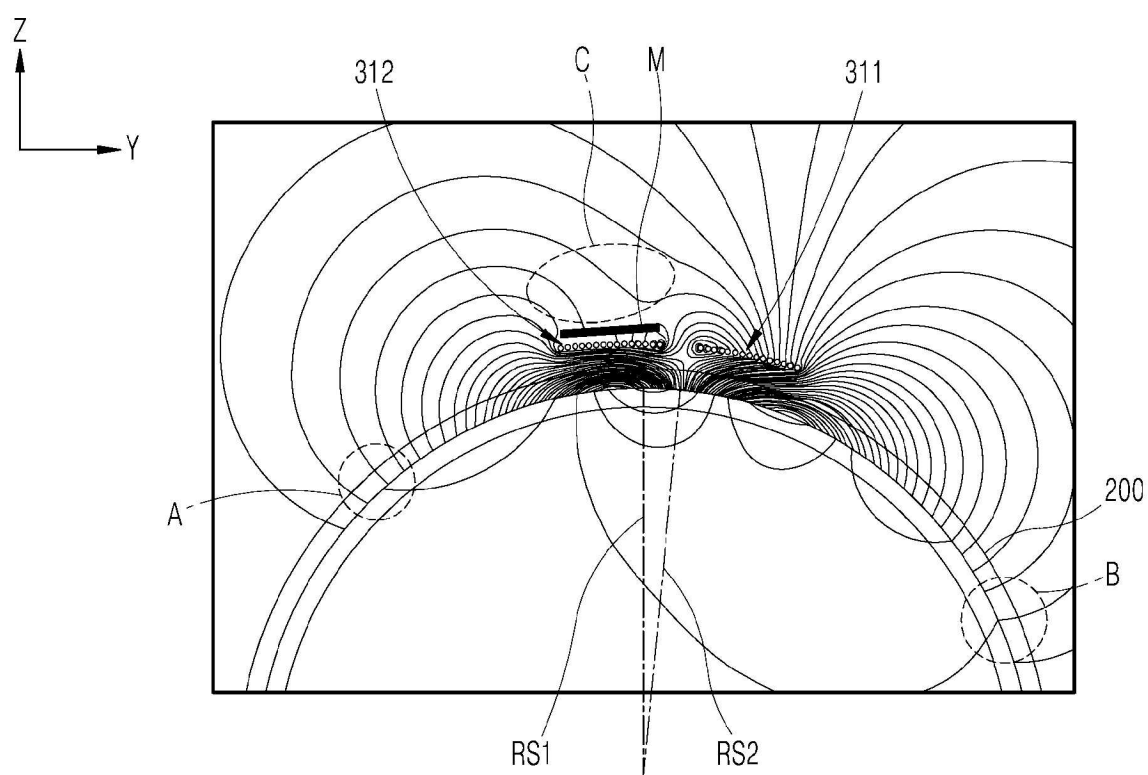
[FIG. 4]



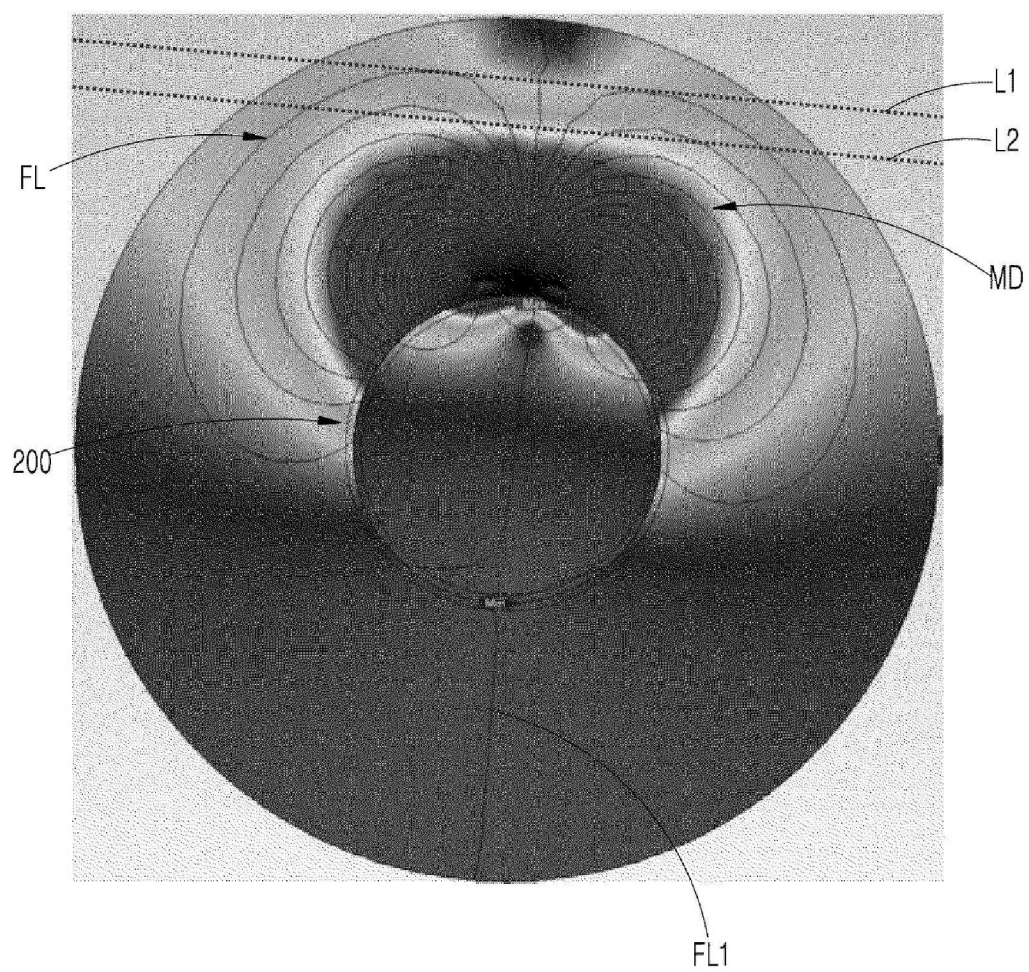
[FIG. 5]



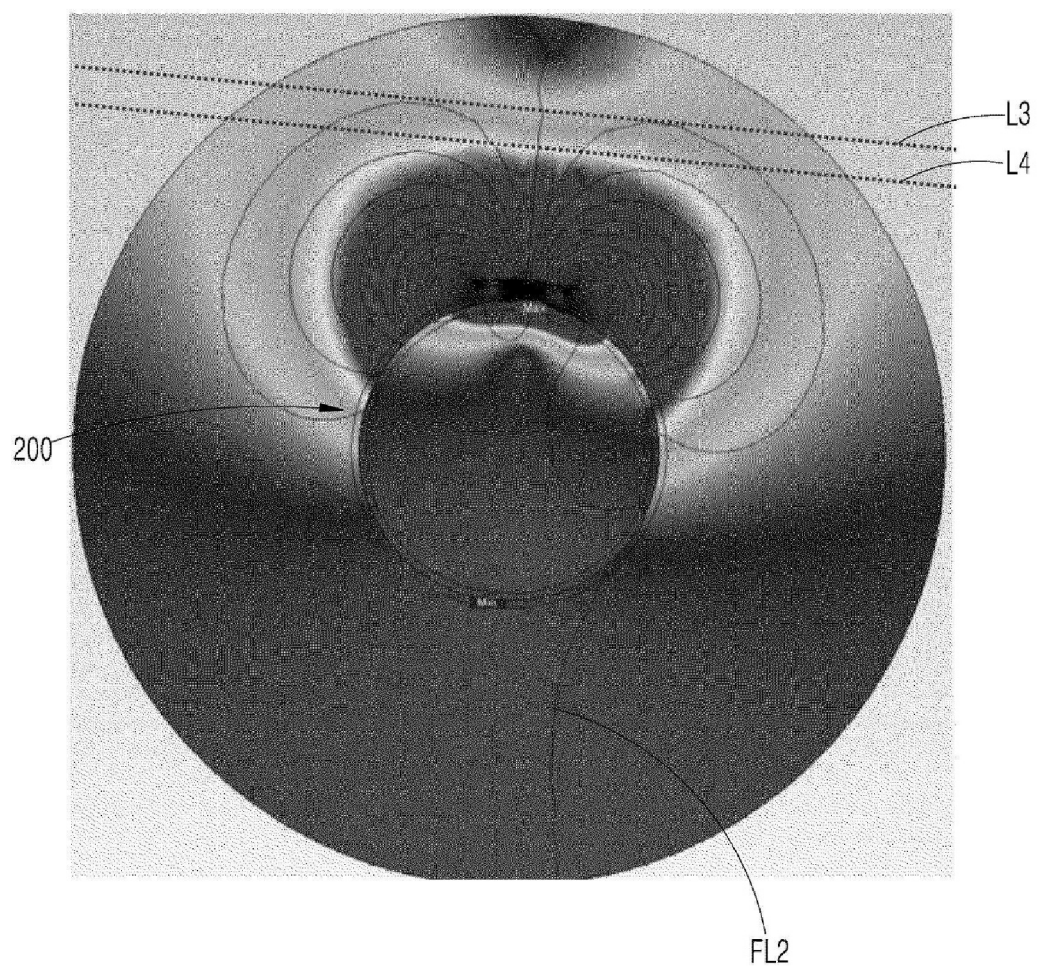
[FIG. 6]



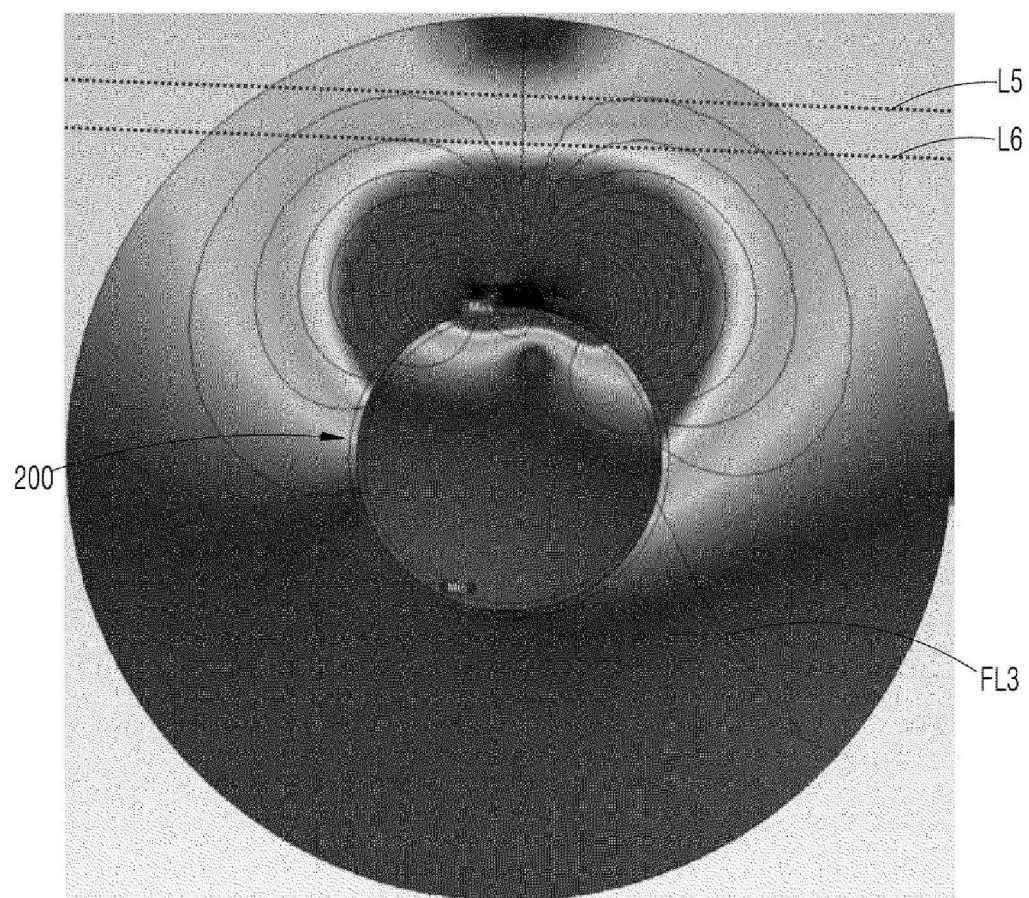
[FIG. 7A]



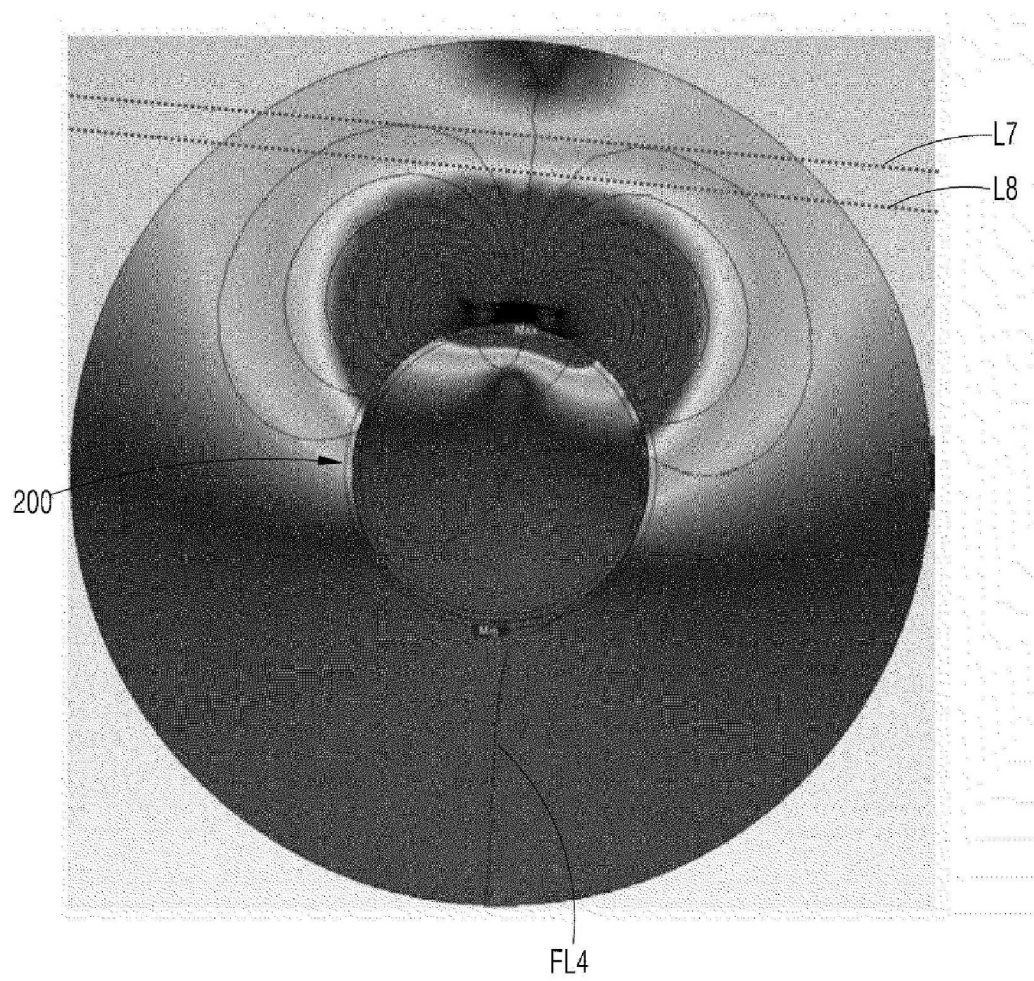
[FIG. 7B]



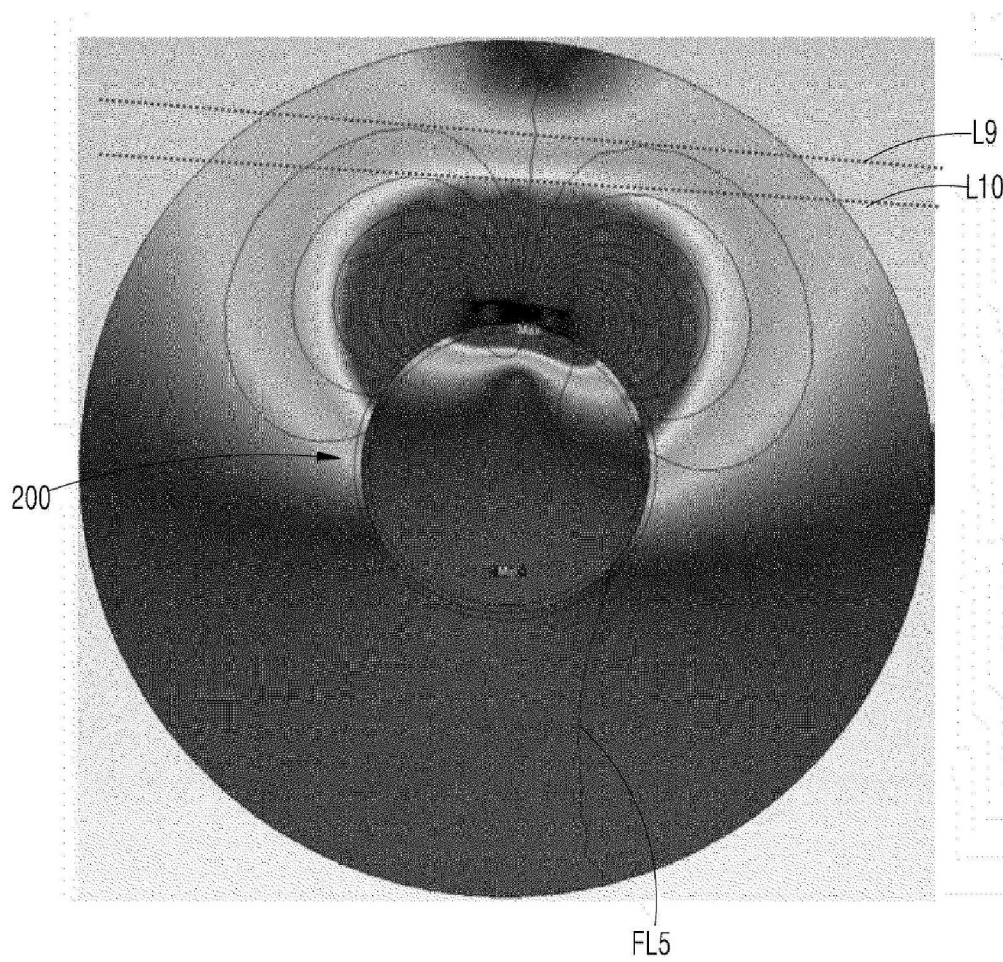
[FIG. 7C]



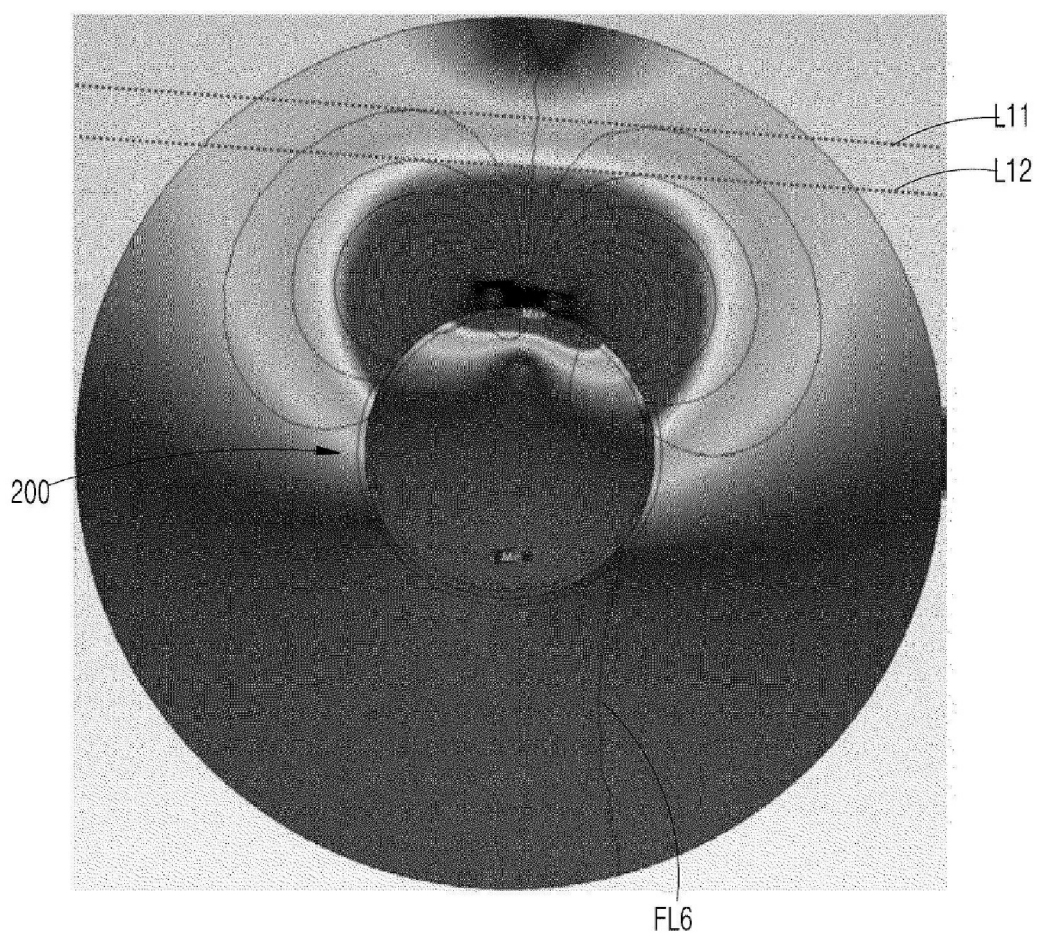
[FIG. 8]



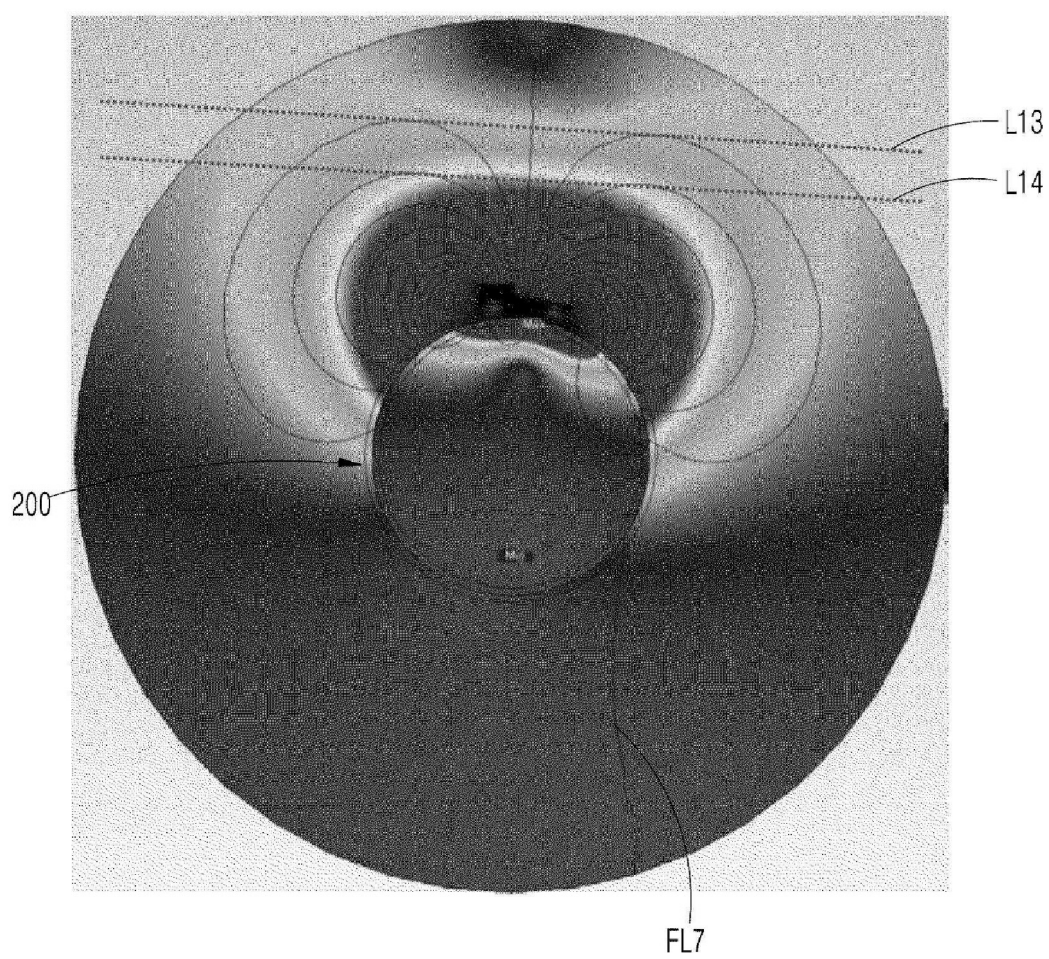
[FIG. 9A]



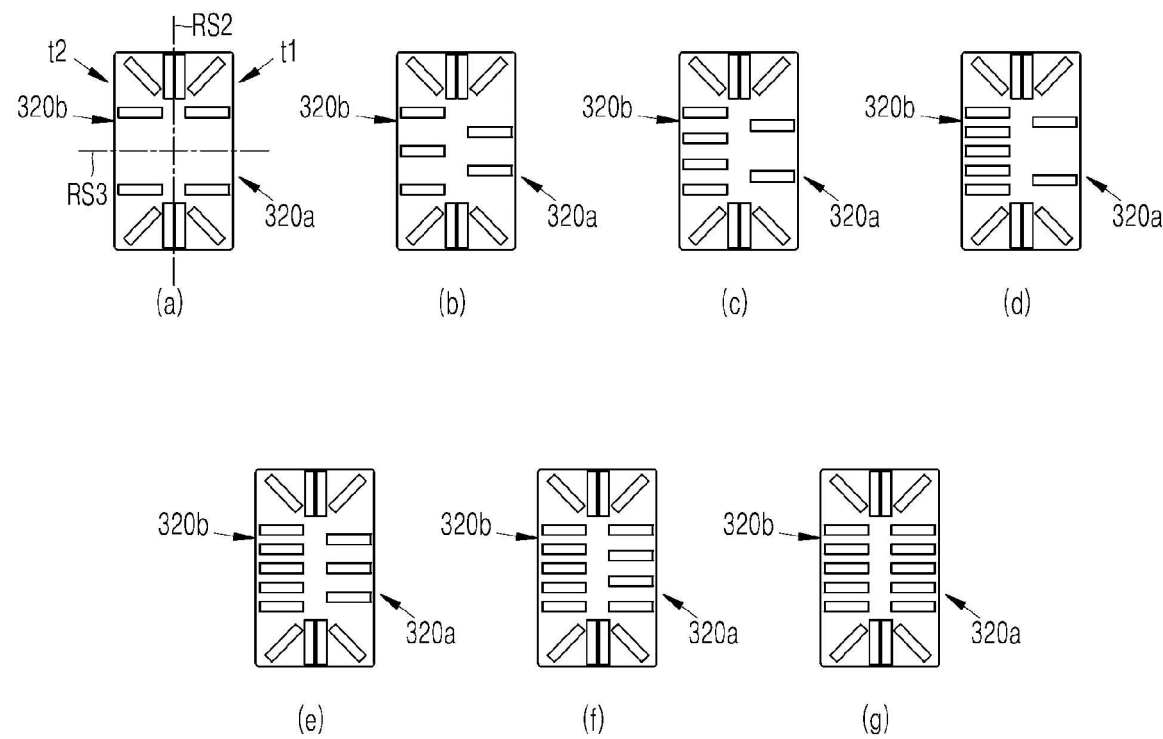
[FIG. 9B]



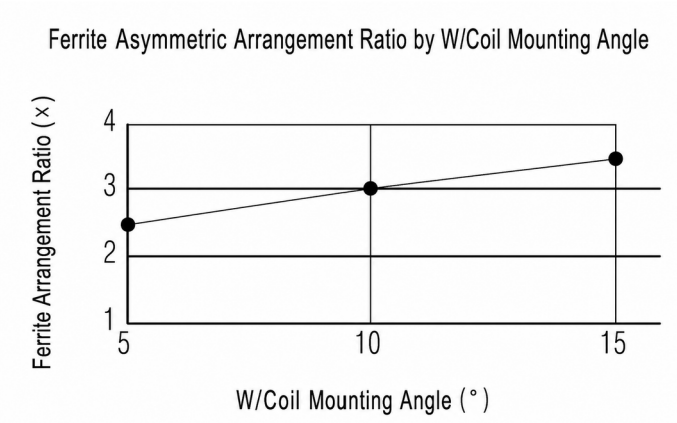
[FIG. 9C]



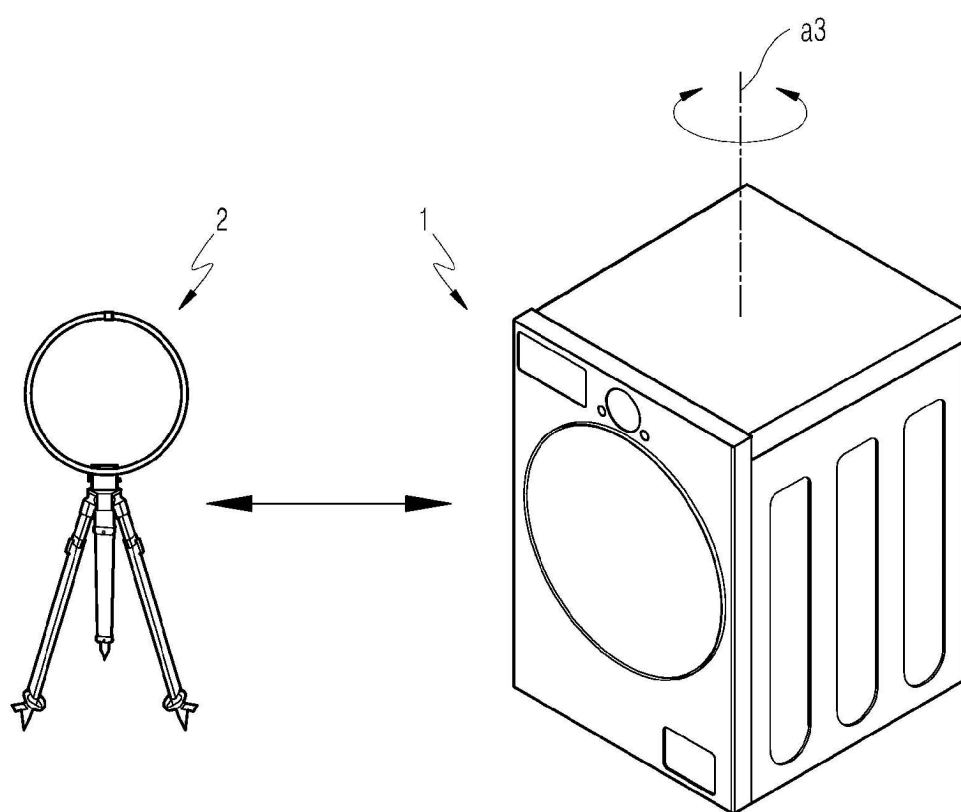
[FIG. 10]



[FIG. 11]



[FIG. 12]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2025/095244

A. CLASSIFICATION OF SUBJECT MATTER**D06F 58/26**(2006.01)i; **H05B 6/36**(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D06F 58/26(2006.01); B09B 3/00(2006.01); D06F 39/00(2006.01); D06F 39/04(2006.01); F23G 5/00(2006.01)

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

Korean utility models and applications for utility models: IPC as above

Japanese utility models and applications for utility models: IPC as above

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

eKOMPASS (KIPO internal) & keywords: 인덕션 모듈(induction module), 워킹 코일(working coil), 영구자석(permanent magnet), 자기력(magnetic force), 각도(angle)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2018-038580 A1 (LG ELECTRONICS INC.) 01 March 2018 (2018-03-01) paragraphs [0128]-[0524] and figures 16-18	1-16
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A	KR 10-0922986 B1 (YOON, Tae So et al.) 22 October 2009 (2009-10-22) paragraphs [0018]-[0030]	1-16

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

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“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

21 July 2025

Date of mailing of the international search report

22 July 2025

Name and mailing address of the ISA/KR

**Korean Intellectual Property Office
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Authorized officer

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/KR2025/095244

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