(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 579 661 A1**

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
11.12.2019 Bulletin 2019/50

(51) Int Cl.:
H05B 6/12 *(2006.01)*

(21) Application number: **19177673.1**

(22) Date of filing: **31.05.2019**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **04.06.2018 JP 2018106949**

(71) Applicant: **Panasonic Intellectual Property Management Co., Ltd.**
Osaka-shi, Osaka 540-6207 (JP)

(72) Inventors:
- **ISAGO, Hiroshi**
  Osaka-shi, Osaka 540-6207 (JP)
- **ASANO, Masato**
  Osaka-shi, Osaka 540-6207 (JP)
- **TAKENAKA, Kazuhiko**
  Osaka-shi, Osaka 540-6207 (JP)

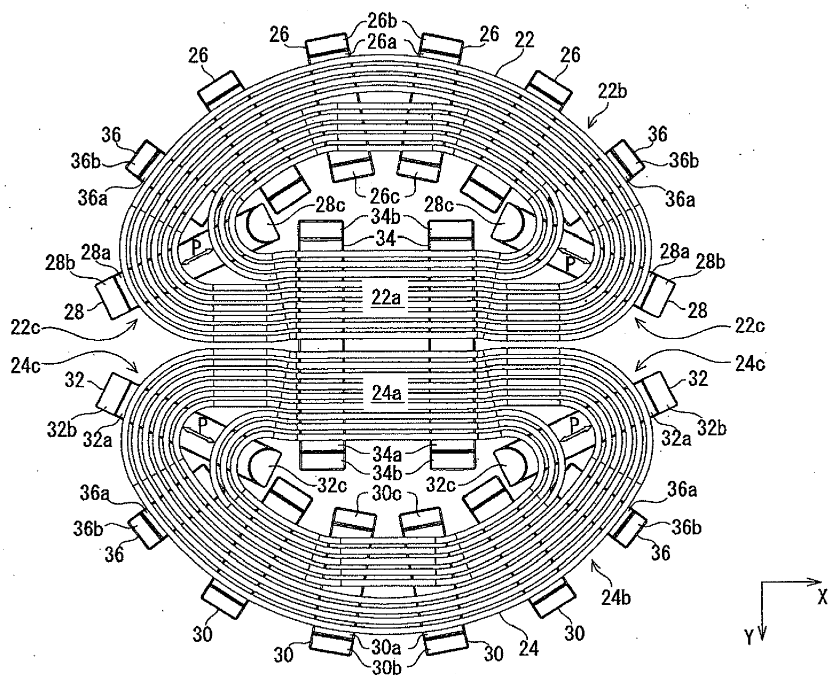
(74) Representative: **Eisenführ Speiser**
Patentanwälte Rechtsanwälte PartGmbB
Postfach 31 02 60
80102 München (DE)

(54) **HEATING COIL UNIT AND INDUCTION HEATING COOKER INCLUDING THE SAME**

(57) PROBLEM TO BE SOLVED: To enable a heating coil unit of an induction heating cooker including first and second heating coils to achieve a heating power capable of inductively heating a cooking container made of a nonmagnetic material while suppressing heat generation and an increase in size.

SOLUTION: A heating coil unit 16 has first and second heating coils 22, 24 and a plurality of ferrites 26 to 36. The plurality of ferrites includes a shared ferrite 34 opened upward and surrounding both an adjacent portion 22a of the first heating coil 22 and an adjacent portion 24a of the second heating coil 24 adjacent to each other.

Fig.5



EP 3 579 661 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a heating coil unit and an induction heating cooker including the same.

BACKGROUND ART

[0002] For example, as described in patent document 1, a heating coil unit including a plurality of heating coils is conventionally known as a heating coil unit of an induction heating cooker inductively heating a cooking container containing an object to be heated. By selectively using the plurality of heating coils, a heating power (generated magnetic force) for the cooking container can finely be adjusted as compared to a heating coil unit including only one heating coil. In the case of the heating coil unit described in Patent Document 1, a ferrite is disposed between the heating coils and functions as a magnetic shielding means so that a magnetic field generated from one heating coil does not affect the other heating coil.

PRIOR ART DOCUMENT

PATENT DOCUMENT

[0003] Patent Document 1: Japanese Laid-Open Patent Publication No. 1-246782

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0004] It is desired to inductively heat a cooking container made of a nonmagnetic material such as aluminum and copper. Therefore, it is conceivable that a large current is applied to a heating coil or that the number of turns of the heating coil is increased. However, in this case, the heating coil itself is raised to high temperature and increased in size. As a result, a heating coil unit generates heat and increases in size.

[0005] Therefore, a problem to be solved by the present invention is to enable a heating coil unit of an induction heating cooker including first and second heating coils to achieve a heating power capable of inductively heating a cooking container made of a nonmagnetic material while suppressing heat generation and an increase in size.

MEANS FOR SOLVING PROBLEM

[0006] To solve the problem, an aspect of the present invention provides
a heating coil unit comprising:

first and second heating coils; and
a plurality of ferrites, wherein
the plurality of ferrites includes a shared ferrite opened upward and surrounding both an adjacent portion of the first heating coil and an adjacent portion of the second heating coil adjacent to each other.

[0007] Another aspect of the present invention provides
an induction heating cooker comprising:

a top plate; and
a heating coil unit disposed under the top plate, wherein
the heating coil unit includes
first and second heating coils, and
a plurality of ferrites, and wherein
the plurality of ferrites includes a shared ferrite opened upward and surrounding both an adjacent portion of the first heating coil and an adjacent portion of the second heating coil adjacent to each other.

EFFECT OF THE INVENTION

[0008] According to the present invention, the heating coil unit of the induction heating cooker including the first and second heating coils can achieve a heating power capable of inductively heating a cooking container made of a nonmagnetic material while suppressing heat generation and an increase in size.

BRIEF DESCRIPTION OF DRAWINGS

[0009]

Fig. 1 is a perspective view of an induction heating cooker according to an embodiment of the present invention.
Fig. 2 is a perspective view of a heating coil unit.
Fig. 3 is an exploded perspective view of the heating coil unit.
Fig. 4 is a perspective view showing a relationship of arrangement of a first heating coil, a second heating coil, and a plurality of ferrites in the heating coil unit.
Fig. 5 is a top view showing the relationship of arrangement of the first heating coil, the second heating coil, and the plurality of ferrites in the heating coil unit.
Fig. 6 is a perspective view of first and third ferrites.
Fig. 7 is a perspective view of second and fourth ferrites.
Fig. 8 is a schematic showing a magnetic field generated in a heating coil.
Fig. 9 is a perspective view of a shared ferrite.
Fig. 10A is a diagram showing a magnetic field distribution of a heating coil unit of an example including the shared ferrite.
Fig. 10B is a diagram showing a magnetic field distribution of a heating coil unit of a comparative ex-

ample without the shared ferrite.

Fig. 11 is a perspective view of an auxiliary ferrite.

MODES FOR CARRYING OUT THE INVENTION

[0010] A heating coil unit according to an aspect of the present invention comprises first and second heating coils and a plurality of ferrites, and the plurality of ferrites includes a shared ferrite opened upward and surrounding both an adjacent portion of the first heating coil and an adjacent portion of the second heating coil adjacent to each other.

[0011] According to the aspect of the present invention, the heating coil unit of an induction heating cooker including the first and second heating coils can achieve a heating power capable of inductively heating a cooking container made of a nonmagnetic material while suppressing heat generation and an increase in size.

[0012] The shared ferrite may have a square-bracket shape, for example.

[0013] In the case that the plurality of ferrites includes first and second ferrites opened upward and surrounding a portion of the first heating coil different from the adjacent portion and third and fourth ferrites opened upward and surrounding a portion of the second heating coil different from the adjacent portion, the shared ferrite preferably has a larger magnetic path cross-sectional area as compared to the first to fourth ferrites. This prevents the shared ferrite from being in a high temperature state and prevents the occurrence of magnetic saturation in the shared ferrite.

[0014] In the case that in the first heating coil, the curvature radius of the portion surrounded by the second ferrite is smaller than the curvature radius of the portion surrounded by the first ferrite and that in the second heating coil, the curvature radius of the portion surrounded by the fourth ferrite is smaller than the curvature radius of the portion surrounded by the third ferrite, preferably, the second ferrite has a larger magnetic path cross-sectional area as compared to the first ferrite, and the fourth ferrite has a larger magnetic path cross-sectional area as compared to the third ferrite. This prevents the second and fourth ferrites from being in a high temperature state.

[0015] The first to fourth ferrites may have a square-bracket shape.

[0016] The plurality of ferrites may include an auxiliary ferrite having an "L" shaped. A magnetic field can further be extended toward the upper side of the heating coils.

[0017] The respective adjacent portions of the first and second heating coils may be linear portions parallel to each other. As a result, a plurality of shared ferrites can be used, and consequently, the heating power can further be increased.

[0018] The first and second heating coils may have a "D" shape.

[0019] In corner portions located at both ends of the linear portion of each of the first and second heating coils, an interval between coil wires adjacent to each other may be made larger than the other intervals between the coil wires. As a result, the magnetic fields generated by the first and second heating coils can be extended in a horizontal direction.

[0020] An induction heating cooker according to another aspect of the present invention comprises a top plate and a heating coil unit disposed under the top plate, the heating coil unit includes first and second heating coils and a plurality of ferrites, and the plurality of ferrites includes a shared ferrite opened upward and surrounding both an adjacent portion of the first heating coil and an adjacent portion of the second heating coil adjacent to each other.

[0021] According to the other aspect of the present invention, the heating coil unit of the induction heating cooker including the first and second heating coils can achieve a heating power capable of inductively heating a cooking container made of a nonmagnetic material while suppressing heat generation and an increase in size.

[0022] An embodiment of the present invention will now be described with reference to the drawings.

[0023] Fig. 1 shows an induction heating cooker according to an embodiment of the present invention. An X-Y-Z coordinate system shown in the figures is for facilitating understanding of the invention and is not intended to limit the invention. An X-axis direction and a Y-axis direction indicate horizontal directions, and a Z-axis direction indicates a vertical direction.

[0024] As shown in Fig. 1, an induction heating cooker 10 is a cooker inductively heating a cooking container C containing an object to be heated T. The induction heating cooker 10 has a top plate 12 made of heat-resistant glass, for example, and having the cooking container C placed thereon, and a housing 14 attached to a lower surface of the top plate 12. A plurality of heating coil units 16 is mounted inside the housing 14. Each of the plurality of the heating coil units 16 is disposed below the top plate 12 and inductively heats the cooking container C placed on a portion of the top plate 12 facing thereto.

[0025] Details of the heating coil unit 16 according to an embodiment of the present invention will hereinafter be described.

[0026] Fig. 2 is a perspective view of an induction heating coil unit. Fig. 3 is an exploded perspective view of the induction heating coil unit.

[0027] As shown in Figs. 2 and 3, in the case of this embodiment, the heating coil unit 16 has a coil base 20, a first heating coil 22, a second heating coil 24, a plurality of ferrites 26 to 36, and a shield plate 38. Although not shown, the heating coil unit 16 includes constituent elements other than these constituent elements, such as an infrared temperature sensor detecting the temperature of the cooking container C located above the heating coil unit 16 across the top plate 12, for example.

[0028] The coil base 20 of the heating coil unit 16 is a member made of a resin material, for example, and is configured to hold the first heating coil 22, the second heating coil 24, and the plurality of the ferrites 26 to 36. Specifically, the coil base 20 has a shallow dish shape having a concave space 20a housing the first and second heating coils 22, 24 and includes in the concave space 20a a multiplicity of partition walls 20b holding the first and second heating coils 22, 24 (coil wires constituting these coils). Since the coil wires are arranged between the adjacent partition walls 20b, the first and second heating coils 22, 24 are held by the coil base 20 with the coil shape thereof maintained.

[0029] The plurality of the ferrites 26 to 36 are attached to a bottom surface of the coil base 20 such that portions (wall portions described later) penetrate the inside of the concave space 20a.

[0030] The first and second heating coils 22, 24 are made up of coil wires produced by twisting a plurality of conductive wires such as aluminum wires or copper wires, for example. In the case of this embodiment, the coil wires are disposed on the coil base 20 such that nine loops are formed when viewed in the vertical direction (viewed in the Z-axis direction) and that the coil wires are stacked in five tiers in the vertical direction.

[0031] Furthermore, in the case of this embodiment, the coil wires are disposed on the coil base 20 such that each of the first and second heating coils 22, 24 has a "D" shape when viewed in the vertical direction (viewed in the Z-axis direction). Therefore, the first and second heating coils 22, 24 respectively include linear portions 22a, 24a and arc portions 22b, 24b.

[0032] The first and second heating coils 22, 24 are held by the coil base 20 and thereby arranged in parallel (in the Y-axis direction) in a posture with coil openings facing in the vertical direction (Z-axis direction). In the case of this embodiment, the first and second heating coils 22, 24 are arranged such that the linear portions 22a, 24a are parallel and adjacent to each other.

[0033] The plurality of ferrites of the heating coil unit 16 includes the first ferrites 26 and the second ferrites 28 used for the first heating coil 22, the third ferrites 30 and the fourth ferrites 32 used for the second heating coil 24, and the shared ferrites 34 shared by the first heating coil 22 and the second heating coil 24.

[0034] In the case of this embodiment, the first ferrites 26 and the third ferrites 30 have the same shape, and the second ferrites 28 and the fourth ferrites 32 have the same shape. In the case of this embodiment, the heating coil unit 16 includes the auxiliary ferrites 36 as ferrites other than the first to fourth ferrites 26 to 32 and the shared ferrites 34. The details of these ferrites 26 to 36 will be described.

[0035] Fig. 4 is a perspective view showing a relationship of arrangement of a first heating coil, a second heating coil, and a plurality of ferrites in the heating coil unit. Fig. 5 is a top view showing the relationship of arrangement of the first heating coil, the second heating coil, and the plurality of ferrites in the heating coil.

[0036] As shown in Figs. 4 and 5, the first ferrites 26 (the third ferrites 30), the second ferrites 28 (the fourth ferrites 32), and the shared ferrites 34 have different shapes.

[0037] Fig. 6 is a perspective view of the first and third ferrites. Fig. 7 is a perspective view of the second and fourth ferrites.

[0038] As shown in Fig. 6, in the case of this embodiment, the first ferrites 26 and the third ferrites 30 have the same shape as described above and have a square-bracket shape. Specifically, the first ferrites 26 and the third ferrites 30 respectively have rectangular parallelepiped main body portions 26a, 30a extending in the horizontal direction (X-axis direction, Y-axis direction), rectangular parallelepiped outer-side wall portions 26b, 30b erecting from one ends of the main body portions 26a, 30a in the vertical direction (Z-axis direction), and rectangular parallelepiped center-side wall portions 26c, 30c erecting from the other ends in the vertical direction.

[0039] As shown in Fig. 5, a portion of the first heating coil 22 is disposed above the main body portions 26a of the first ferrites 26 and between the outer-side wall portions 26b and the center-side wall portions 26c. Specifically, a portion of the coil base 20 is present between the main body portions 26a and the first heating coil 22. The outer-side wall portions 26b are located on the outer side of the first heating coil 22, and the center-side wall portions 26c are located on the center side (within the coil opening) of the first heating coil 22. In other words, the portion of the first heating coil 22 is surrounded by the first ferrites 26 opened upward (opened toward the top plate 12).

[0040] As shown in Fig. 5, a portion of the second heating coil 24 is disposed above the main body portions 30a of the third ferrites 30 and between the outer-side wall portions 30b and the center-side wall portions 30c. Specifically, a portion of the coil base 20 is present between the main body portions 30a and the second heating coil 24. The outer-side wall portions 30b are located on the outer side of the second heating coil 24, and the center-side wall portions 30c are located on the center side (within the coil opening) of the second heating coil 24. In other words, the portion of the second heating coil 24 is surrounded by the third ferrites 26 opened upward (opened toward the top plate 12).

[0041] As shown in Fig. 7, in the case of this embodiment, the second ferrites 28 and the fourth ferrites 32 have the same shape as described above and have a square-bracket shape. Specifically, the second ferrites 28 and the fourth ferrites 32 respectively have rectangular parallelepiped main body portions 28a, 32a extending in the horizontal direction (X-axis direction, Y-axis direction), rectangular parallelepiped outer-side wall portions 28b, 32b erecting from one ends of the main body portions 28a, 32a in the vertical direction (Z-axis direction), and semicylindrical center-side wall portions 28c, 32c erecting from the other ends in the vertical direction.

[0042] As shown in Fig. 5, a portion of the first heating coil 22 is disposed above the main body portions 28a of the second ferrites 28 and between the outer-side wall portions 28b and the center-side wall portions 28c. Specifically, a portion of the coil base 20 is present between the main body portions 28a and the first heating coil 22. The outer-side wall portions 28b are located on the outer side of the first heating coil 22, and the center-side wall portions 28c are located on the center side (within the coil opening) of the first heating coil 22. In other words, the portion of the first heating coil 22 is surrounded by the second ferrites 28 opened upward (opened toward the top plate 12).

[0043] Similarly, as shown in Fig. 5, a portion of the second heating coil 24 is disposed above the main body portions 32a of the fourth ferrites 32 and between the outer-side wall portions 32b and the center-side wall portions 32c. Specifically, a portion of the coil base 20 is present between the main body portions 32a and the second heating coil 24. The outer-side wall portions 32b are located on the outer side of the second heating coil 24, and the center-side wall portions 32c are located on the center side (within the coil opening) of the second heating coil 24. In other words, the portion of the second heating coil 24 is surrounded by the fourth ferrites 32 opened upward (opened toward the top plate 12).

[0044] As shown in Figs. 6 and 7, the shape of the first ferrites 26 is different from the shape of the second ferrites 28 and the shape of the third ferrites 30 is different from the shape of the fourth ferrites 32 because of the reason described below. It is noted that the reason why the third ferrites 30 and the fourth ferrites 32 are different in shape is the same as the reason why the first ferrites 26 and the second ferrites 28 are different in shape.

[0045] As shown in Fig. 5, the first ferrites 26 are opened upward and surrounds the arc portion 22b of the first heating coil 22. The second ferrites 28 are opened upward and surrounds corner portions 22c located at both ends of the linear portion 22a, i.e., between the linear portion 22a and the arc portion 22b, of the first heating coil 22.

[0046] As shown in Fig. 5, in the first heating coil 22, when the arc portion 22b and the corner portion 22c are compared, the latter has a smaller curvature radius. Therefore, the center-side wall portions 28c of the second ferrites 28 are formed into a semicylindrical shape (formed into a semicircular shape when viewed from above (viewed in the Z direction)) so as not to come too close to the first heating coil 22, unlike the rectangular parallelepiped center-side wall portions 26c of the first ferrites 26.

[0047] Additionally, the second ferrites 28 have a larger magnetic path cross-sectional area as compared to the first ferrites 26. This will specifically be described with reference to Fig. 8.

[0048] Fig. 8 is a schematic showing a magnetic field generated in the first heating coil.

[0049] As shown in Fig. 8, when a current I flows through the first heating coil 22, a magnetic flux MF is generated, circling around each of multiple portions of the first heating coil 22. The density of the magnetic flux MF is higher in a portion with a small curvature radius than a portion with a large curvature radius.

[0050] Therefore, the magnetic flux density in the second ferrites 28 disposed in the corner portions 22c of the first heating coil 22 having a small curvature radius becomes higher than the magnetic flux density in the first ferrites 26 disposed in the arc portion having a large curvature radius. As a result, the second ferrites 28 are more likely to be in a high temperature state as compared to the first ferrites 26.

[0051] To prevent the second ferrites 28 from being in a high temperature state, the second ferrites 28 have a larger magnetic path cross-sectional area as compared to the first ferrites 26, so that the second ferrites 28 and the first ferrites 26 are different in shape.

[0052] Specifically, for example, the magnetic flux generated from the first heating coil 22 and collected in the second ferrite 28 mainly enters from a tip of one of the outer-side wall portion 28b and the center-side wall portion 28c of the second ferrite 28 toward the main body portion 28a, moves from the main body portion 28a toward the other side, and exits from the other tip. As a result, the magnetic field spreads upward, i.e., toward the cooking container C on the top plate 12. The magnetic flux passes through the first ferrite 26 in the same way.

[0053] An area of a cross section (magnetic path cross-sectional area) orthogonal to a path (magnetic path) of such a magnetic flux is made larger in the second ferrites 28 than in the first ferrite 26. As a result, the magnetic flux density in the second ferrite 28 is reduced as compared to the magnetic flux density in the first ferrite 26. Consequently, the second ferrite 28 is in the temperature state at the same level as the first ferrite 26 and is prevented from being in the high temperature state.

[0054] In the case of this embodiment, as shown in Figs. 6 and 7, the outer-side wall portion 26b of the first ferrite 26 and the outer-side wall portion 28b of the second ferrite 28 both disposed on the outer side of the first heating coil 22 have different thicknesses d1, d2, and d2 is larger than d1. As a result, the magnetic path cross-sectional area of the second ferrite 28 is made larger than the magnetic path cross-sectional area of the first ferrite 26.

[0055] Similarly, in the second heating coil 24, the third ferrites 30 are opened upward and surrounds the arc portion 24b of the second heating coil 24. The fourth ferrites 32 are opened upward and surrounds corner portions 24c located at both ends of the linear portion 24a, i.e., between the linear portion 24a and the arc portion 24b, of the second heating coil 24.

[0056] In the second heating coil 24 as well, when the arc portion 24b and the corner portion 24c are compared, the latter has a smaller curvature radius. Therefore, the center-side wall portions 32c of the fourth ferrites 28 are formed into a semicylindrical shape (formed into a semicircular shape when viewed from above (viewed in the Z direction)) so as not to come too close to the second heating coil 24, unlike the rectangular parallelepiped center-side wall portions 30c of the third ferrites 26.

[0057] The magnetic path cross-sectional area of the fourth ferrite 32 is made larger than the magnetic path cross-sectional area of the third ferrite 30 for the same reason and with the same method as the second ferrite 28.

[0058] In the case of this embodiment, as shown in Fig. 5, in the corner portions 22c, 24d of the first and second heating coils 22, 24 in which the second and fourth ferrites 28, 32 are disposed, an interval between the coil wires adjacent to each other is made larger than an interval between the coil wires in the portions other than the corner portions. In the case of this embodiment, an interval P between the third and fourth coil wires from the center side is expanded as compared to the intervals of the other coil wires. By adjusting the distance between the coil wires in this way, the first and second heating coils 22, 24 can be expanded outward without reducing the curvature radius of the coil wire closest to the center in the corner portions 22c, 22d. As a result, the magnetic fields generated by the first and second heating coils 22, 24 can be extended in the horizontal direction (X-axis direction). If the first and second heating coils 22, 24 are expanded outward without expanding the pitch interval, the curvature radius becomes smaller in the corner portions, which eliminates spaces for arrangement of the center-side wall portions 28c, 32c of the second and fourth ferrites 28, 32.

[0059] As shown in Fig. 5, the shared ferrites 34 are shared by the first and second heating coils 22, 24 unlike the first to fourth ferrites 26 to 32.

[0060] Fig. 9 is a perspective view of the shared ferrite.

[0061] As shown in Fig. 9, in the case of this embodiment, the shared ferrites 34 have a square-bracket shape. Specifically, the shared ferrites 34 include a rectangular parallelepiped main body portion 34a extending in the horizontal direction (X-axis direction, Y-axis direction) and rectangular parallelepiped wall portions 34b erecting from both respective ends of the main body portion 34a in the vertical direction (Z-axis direction).

[0062] As shown in Fig. 5, the linear portion 22a of the first heating coil 22 and the linear portion 24a of the second heating coil 24 adjacent to each other are disposed above the main body portion 34a of the shared ferrite 34 and between the two wall portions 34b. Specifically, a portion of the coil base 20 is present between the main body portion 34a and the linear portions 22a, 24a of the first and second heating coils 22, 24. Additionally, one of the wall portions 34b is located in the coil opening of the first heating coil 22, and the other wall portion 34b is located in the coil opening of the second heating coil 24. In other words, the linear portion 22a of the first heating coil 22 and the linear portion 24a of the second heating coil 24 adjacent to each other are surrounded together by the shared ferrite 34 in a partially opened state (opened toward the top plate 12).

[0063] The reason for using such a shared ferrite 34 will be described. The description will be made with reference to an example and a comparative example.

[0064] Fig. 10A shows a magnetic field distribution of a heating coil unit of an example including the shared ferrite. Fig. 10B shows a magnetic field distribution of a heating coil unit of a comparative example without the shared ferrite.

[0065] Figs. 10A and 10B show the magnetic field distributions when currents flow in the same direction through the respective linear portions 22a, 24a of the first and second heating coils 22, 24. In the case of the comparative example shown in Fig. 10B, a ferrite 150 opened upward and surrounding the linear portion 22a of the first heating coil 22 and a ferrite 152 opened upward and surrounding the linear portion 24a of the second heating coil 24 are used instead of the shared ferrite. The ferrite 150 has the same shape as the first ferrite 26, and the ferrite 152 has the same shape as the third ferrite 30.

[0066] As shown in Fig. 10A, when the shared ferrite 34 is used, a magnetic flux MF1 is generated and circles around both of the linear portions 22a, 24a of the first and second heating coils 22, 24 while passing through the inside of the shared ferrite 34. The magnetic flux MF1 is stronger than a magnetic flux MF2 passing through the first ferrite 26 and a magnetic flux MF2 passing through the third ferrite 30. Specifically, since the surrounded coil wires are doubled, the magnetic flux density in the shared ferrite 34 is higher than the magnetic flux density in the first ferrite 26 or the third ferrite 30.

[0067] On the other hand, in the case of the comparative example shown in Fig. 10B, a magnetic flux MF4 is generated and circles around the linear portion 22a of the first heating coil 22 while passing through the ferrite 150. At the same time, a magnetic flux MF5 is generated and circles around the linear portion 24a of the second heating coil 24 while passing through the ferrite 152.

[0068] Since the number of the surrounded coil wires is the same, a magnetic flux MF4 generated in the ferrite 150 is the same as the magnetic flux MF2 generated in the first ferrite 26, and a magnetic flux MF5 generated in the ferrite 152 is the same as the magnetic flux MF3 generated in the third ferrite 30. However, the magnetic flux passing through an outer-side wall portion 150b of the ferrite 150 and the magnetic flux passing through an outer-side wall portion 152b of the ferrite 152 are directed opposite to each other and therefore cancel each other.

[0069] As shown in Fig. 10A, in the case of the heating coil unit of the example including the shared ferrite 34, a distance in a parallel direction (Y-axis direction) can be made as small as possible between the linear portion 22a of the first heating coil 22 and the linear portion 24a of the second heating coil 24. This suppresses the mutual cancellation between the magnetic flux generated around the coil wires in the linear portion 22a of the first heating coil 22 and the magnetic flux generated around the coil wires in the linear portion 24a of the second heating coil 24.

[0070] On the other hand, in the case of the comparative example shown in Fig. 10B, the outer-side wall portion 150b of the ferrite 150 and the outer-side wall portion 152b of the ferrite 152 exist between the first heating coil 22 and the second heating coil 24. Therefore, the linear portion 22a of the first heating coil 22 and the linear portion 24a of the second heating coil 24 cannot be made close to each other as in the example.

[0071] Therefore, in the case of the comparative example, the presence of the ferrites between the first heating coil 22 and the second heating coil 24 causes a portion of the magnetic flux generated from the first heating coil 22 and a portion of the magnetic flux generated from the second heating coil 24 to cancel each other.

[0072] On the other hand, in the case of the embodiment shown in Fig. 10A, the use of the shared ferrite 34 suppresses the mutual cancelation between the magnetic flux generated from the first heating coil 22 and the magnetic flux generated from the second heating coil 24. Therefore, an electric power supplied to the first and second heating coils 22, 24 can be converted into a magnetic field with high conversion efficiency. As a result, the first and second heating coils 22, 24 can achieve a high heating power without applying a large current to the first and second heating coils 22, 24 and without increasing the number of turns. Consequently, the heating coil unit 16 is prevented from generating heat and increasing in size and can inductively heat a cooking container made of a nonmagnetic material such as aluminum and copper.

[0073] As shown in Fig. 5, the number of the coil wires surrounded by the shared ferrite 34 is doubled as compared to the first to fourth ferrites 26 to 32. Therefore, the shared ferrite 34 preferably has a larger magnetic path cross-sectional area as compared to the first to fourth ferrites 26 to 32. This prevents the shared ferrite 34 from being in a high temperature state and prevents the occurrence of magnetic saturation in the shared ferrite 34. In the case of this embodiment, as shown in Figs. 6, 7, and 9, the magnetic path cross-sectional area (the cross section orthogonal to the extending direction) of the main body portion 34a of the shared ferrite 34 is made larger as compared to the main body portions 26a to 32a of the first to fourth ferrites 26 to 32.

[0074] As shown in Fig. 5, the auxiliary ferrites 36 differ from the first to fourth ferrites 26 to 32 and the shared ferrite 34 and does not surround portions of the first and second heating coils 22, 24 in a partially opened state.

[0075] Fig. 11 is a perspective view of the auxiliary ferrite.

[0076] As shown in Fig. 11, in the case of this embodiment, the auxiliary ferrite 36 has an "L" shape. Specifically, the auxiliary ferrite 36 has a rectangular parallelepiped main body portion 36a extending in the horizontal direction (X-axis direction, Y-axis direction) and a rectangular parallelepiped outer-side wall portion 36b erecting from one end of the main body portion 36a in the vertical direction (Z-axis direction).

[0077] As shown in Fig. 5, the auxiliary ferrites 36 are disposed on each of the first and second heating coils 22, 24. In the case of this embodiment, the auxiliary ferrites 36 are disposed between the first ferrites 26 and the second ferrites 28 and disposed between the third ferrites 30 and the fourth ferrites 32. The first and second heating coils 22, 24 are disposed above the main body portions 36a of the auxiliary ferrites 36. Specifically, a portion of the coil base 20 is present between the main body portions 36a and the first and second heating coils 22, 24. The outer-side wall portions 36b are located on the outer side of the first and second heating coils 22, 24.

[0078] The auxiliary ferrites 36 as described above can be disposed for portions of the first and second heating coils 22, 24 in which the first to fourth ferrites 26 to 32 cannot be disposed. The auxiliary ferrite 36 can further extend the magnetic field upward.

[0079] The auxiliary ferrites 36 may be disposed between the first ferrites 26 or between the third ferrites 30.

[0080] As shown in Fig. 3, the shield plate 38 is a member made of a metal material such as aluminum and includes a bottom portion 38a and a cylindrical portion 38b erecting from an outer circumferential edge of the bottom portion 38a. The shield plate 38 is fitted to an outer circumferential surface 20c of the coil base 20. The bottom portion 38a of the shield plate 38 is provided with a plurality of through-holes for cooling the first and second heating coils 22, 24, the first to fourth ferrites 26 to 32, the shared ferrites 34, and the auxiliary ferrites 36. The plurality of through-holes is disposed such that the bottom portion 38a of the shield plate 38 is present below the first to fourth ferrites 26 to 32, the shared ferrites 34, and the auxiliary ferrites 36. This suppresses the leakage of the magnetic flux from the ferrites to the lower side thereof.

[0081] According to this embodiment as described above, the heating coil unit 16 of the induction heating cooker 10 including the first and second heating coils 22, 24 can achieve a heating power capable of inductively heating a cooking container made of a nonmagnetic material while suppressing heat generation and an increase in size. In other words, the first and second heating coils 22, 24 can achieve a high heating power without applying a large current to the first and second heating coils 22, 24 and without increasing the number of turns.

[0082] Although the present invention has been described with reference to the embodiment, the present invention is not limited to the embodiment.

[0083] For example, in the case of this embodiment, as shown in Figs. 6, 7, and 9, the first to fourth ferrites 26 to 32 and the shared ferrites 34 have a so-called square-bracket shape; however, the embodiments of the present invention are not limited thereto. For example, the ferrites may have a "C" shape or a "U" shape. Therefore, the first to fourth ferrites and the shared ferrites may have any shape as long as the ferrites can surround the first and second heating coils while being opened upward.

[0084] In the case of the embodiment, the first and second heating coils have a so-called "D" shape; however, the embodiments of the present invention are not limited thereto. For example, the heating coils may have an oval shape or an elliptical shape.

[0085] In the case of the embodiment, the portions of the first and second heating coils adjacent to each other and surrounded by the shared ferrites have a linear shape; however, the embodiments of the present invention are not limited thereto. It is noted that the linear shape is preferable since a plurality of shared ferrites can be used as shown in Fig. 5.

[0086] Therefore, in a broad sense, the heating coil unit according to the embodiment of the present invention has the first and second heating coils and a plurality of ferrites, and the plurality of ferrites includes a shared ferrite opened upward and surrounding an adjacent portion of the first heating coil and an adjacent portion of the second heating coil adjacent to each other together.

INDUSTRIAL APPLICABILITY

[0087] The present invention is applicable to any heating coil unit of an induction heating cooker including a plurality of heating coils.

EXPLANATIONS OF LETTERS OR NUMERALS

[0088]

16	heating coil unit
22	first heating coil
22a	adjacent portion (linear portion)
24	second heating coil
24a	adjacent portion (linear portion)
26	first ferrite
28	second ferrite
30	third ferrite
32	fourth ferrite
34	shared ferrite
36	auxiliary ferrite

Claims

1. A heating coil unit comprising:

first and second heating coils; and
a plurality of ferrites, wherein
the plurality of ferrites includes a shared ferrite opened upward and surrounding both an adjacent portion of the first heating coil and an adjacent portion of the second heating coil adjacent to each other.

2. The heating coil unit according to claim 1, wherein the shared ferrite has a square-bracket shape.

3. The heating coil unit according to claim 1 or 2, wherein
the plurality of ferrites includes first and second ferrites opened upward and surrounding a portion of the first heating coil different from the adjacent portion and third and fourth ferrites opened upward and surrounding a portion of the second heating coil different from the adjacent portion, and wherein
the shared ferrite has a larger magnetic path cross-sectional area as compared to the first to fourth ferrites.

4. The heating coil unit according to claim 3, wherein
in the first heating coil, the curvature radius of the portion surrounded by the second ferrite is smaller than the curvature radius of the portion surrounded by the first ferrite, wherein
the second ferrite has a larger magnetic path cross-sectional area as compared to the first ferrite, wherein
in the second heating coil, the curvature radius of the portion surrounded by the fourth ferrite is smaller than the curvature radius of the portion surrounded by the third ferrite, and wherein
the fourth ferrite has a larger magnetic path cross-sectional area as compared to the third ferrite.

5. The heating coil unit according to claim 3 or 4, wherein the first to fourth ferrites have a square-bracket shape.

6. The heating coil unit according to any one of claims 1 to 5, wherein the plurality of ferrites includes an auxiliary ferrite having an "L" shaped.

7. The heating coil unit according to any one of claims 1 to 6, wherein the respective adjacent portions of the first and second heating coils are linear portions parallel to each other.

8. The heating coil unit according to claim 7, wherein the first and second heating coils have a "D" shape.

9. The heating coil unit according to claim 7 or 8, wherein in corner portions located at both ends of the linear portion of each of the first and second heating coils, an interval between coil wires adjacent to each other is made larger than the other intervals between the coil wires.

10. An induction heating cooker comprising:

a top plate; and
a heating coil unit disposed under the top plate, wherein
the heating coil unit includes
first and second heating coils, and
a plurality of ferrites, and wherein
the plurality of ferrites includes a shared ferrite opened upward and surrounding both an adjacent portion of the first heating coil and an ad-

jacent portion of the second heating coil adjacent to each other.

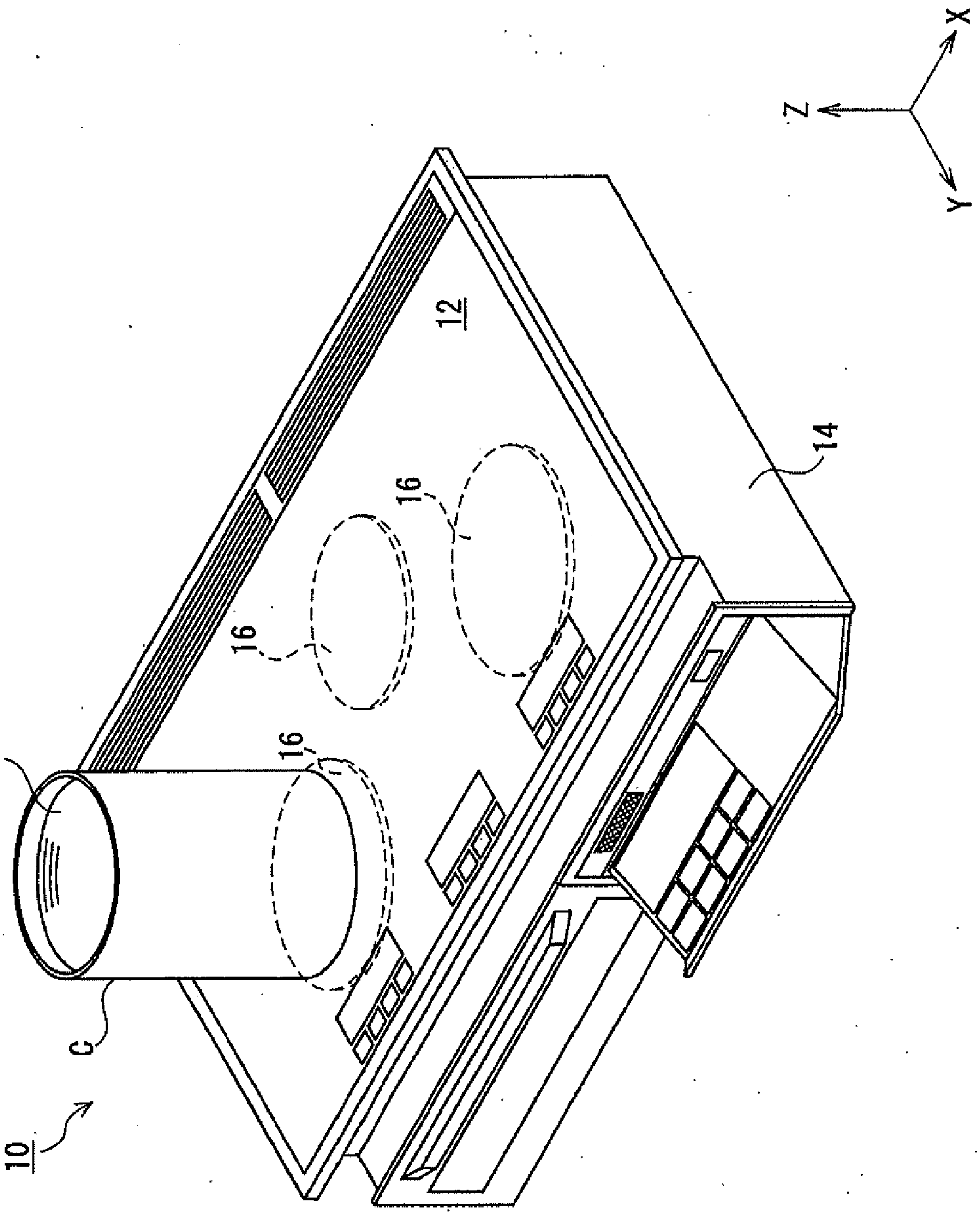


Fig.1

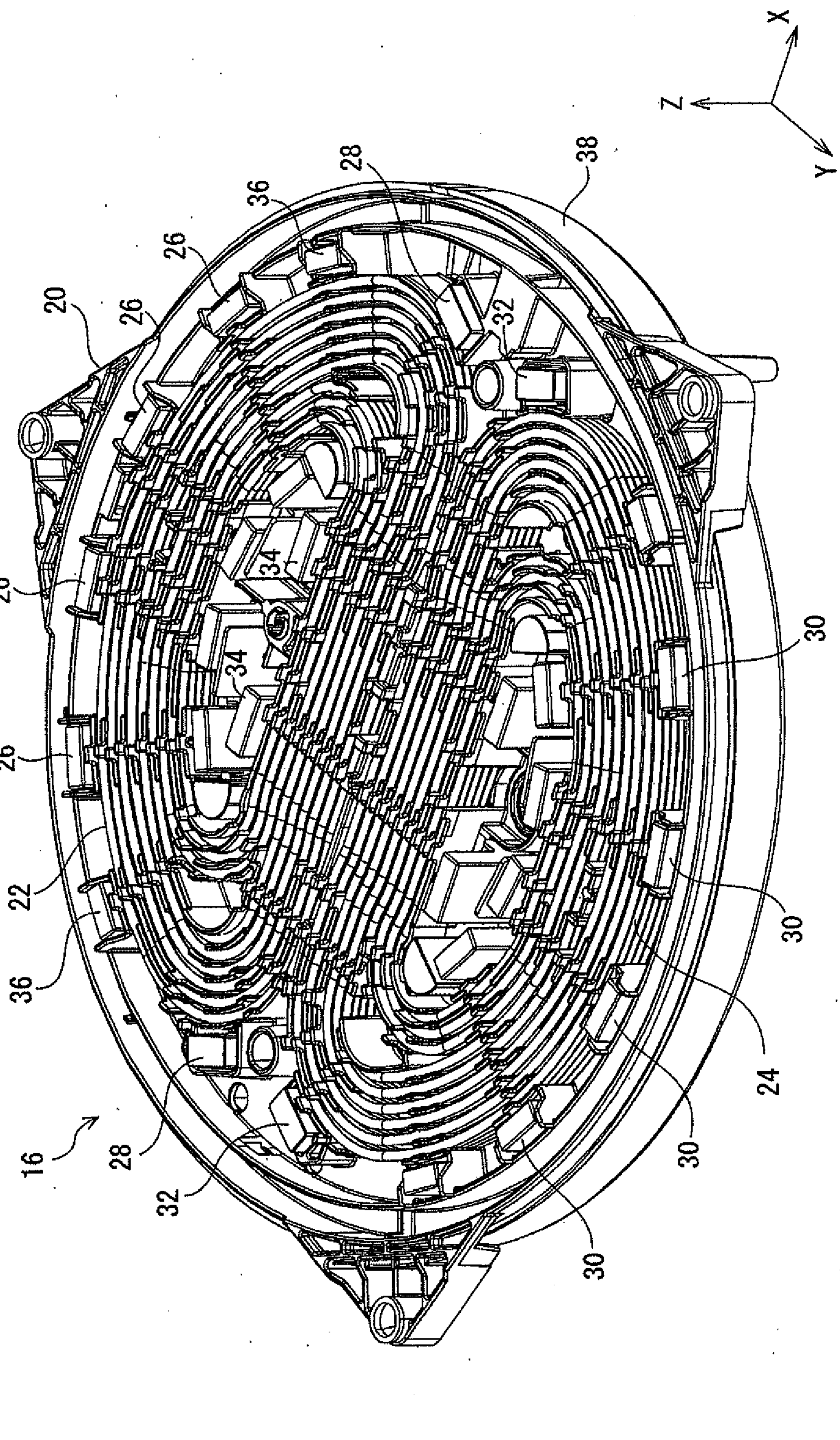
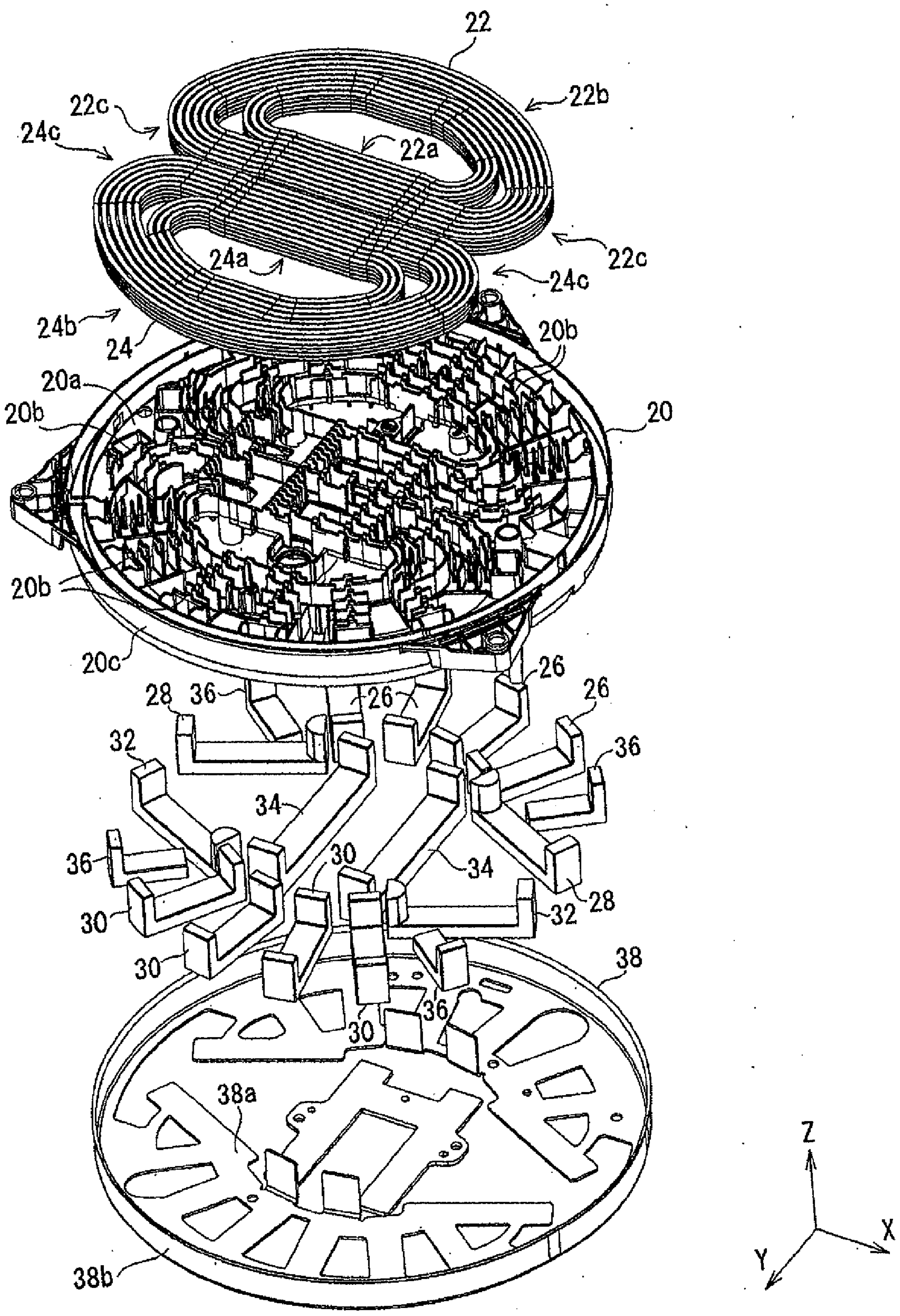


Fig.2

Fig.3


22
22c
22b
24c
22a
22c
24a
24c
24b
24
20b
20a
20b
20
20b
20c
26
28
36
26
26
32
36
34
36
30
34
30
28
32
30
38
30
36
38a
Z
X
Y
38b

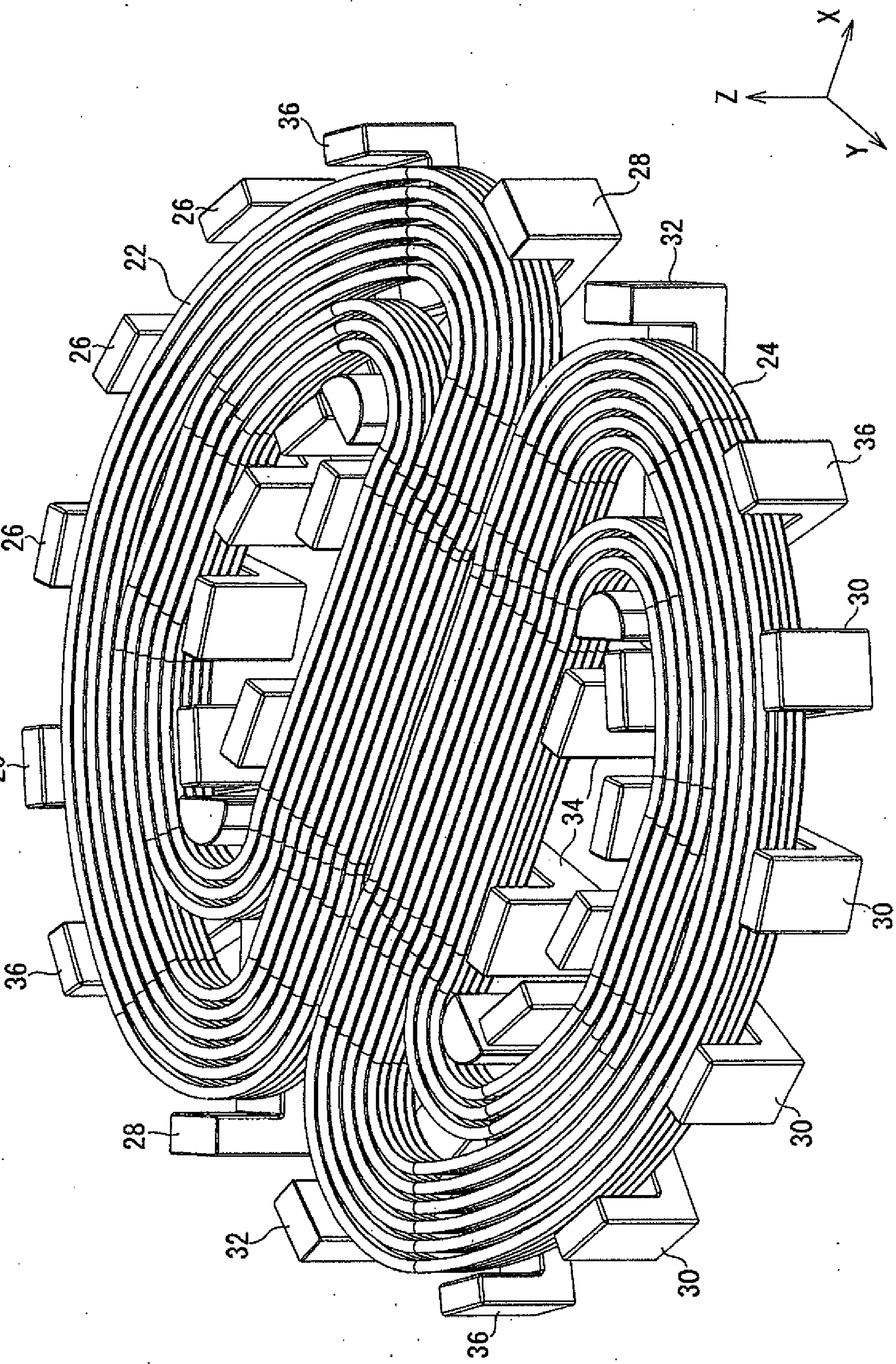


Fig.4

Fig.5

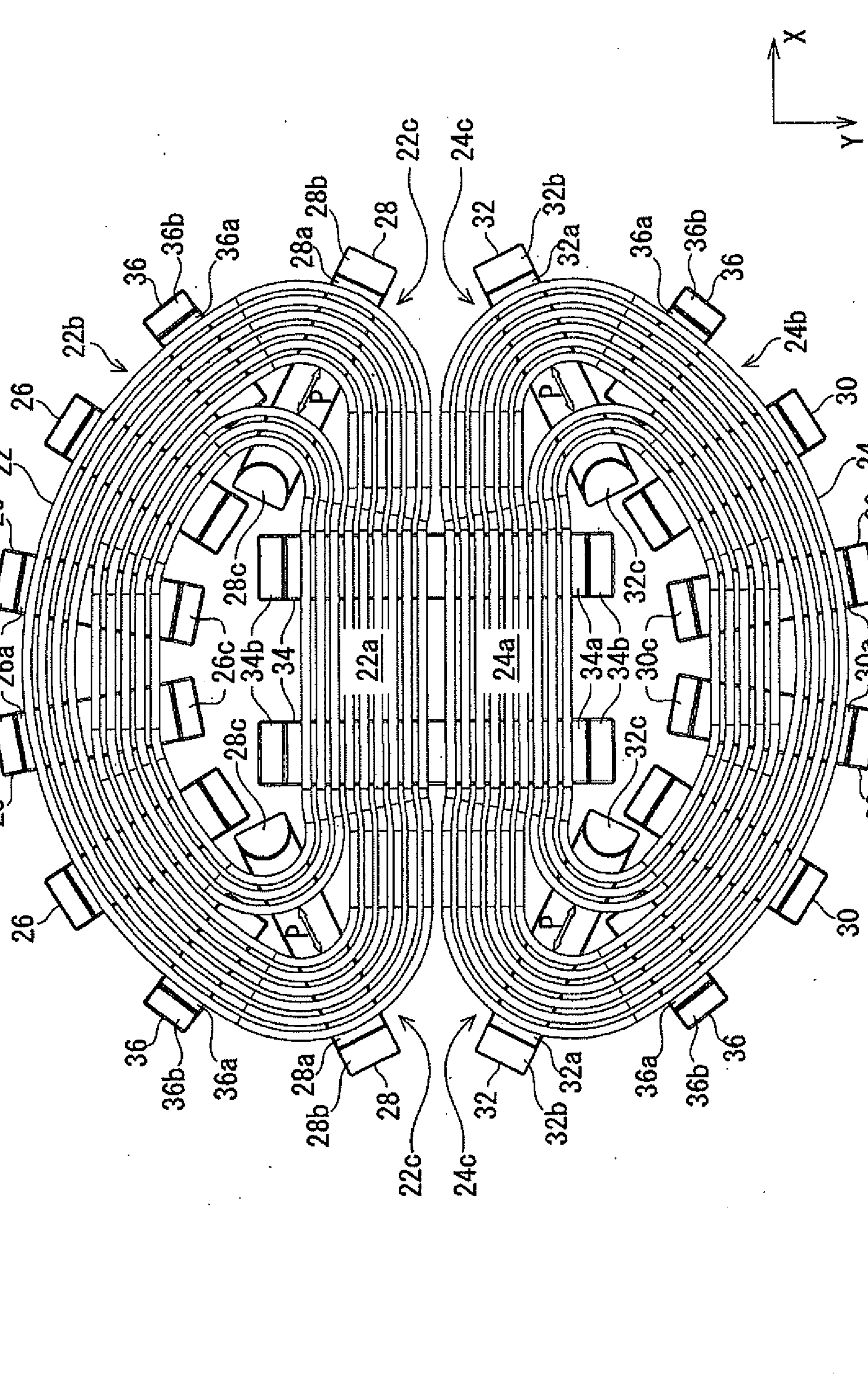

X
Y
22
22a
22b
22c
24
24a
24b
24c
26
26a
26b
26c
28
28a
28b
28c
30
30a
30b
30c
32
32a
32b
32c
34
34a
34b
36
36a
36b
P

Fig.6

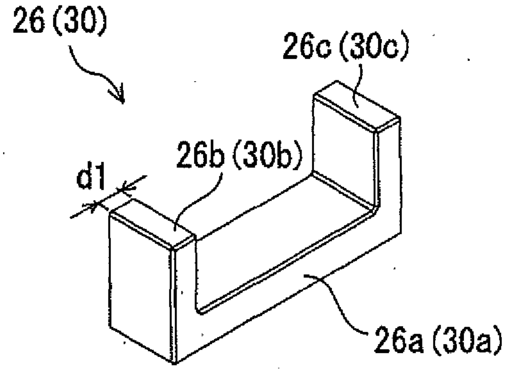


Fig.7

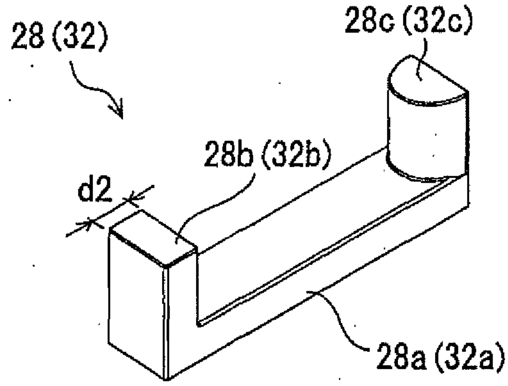


Fig.8

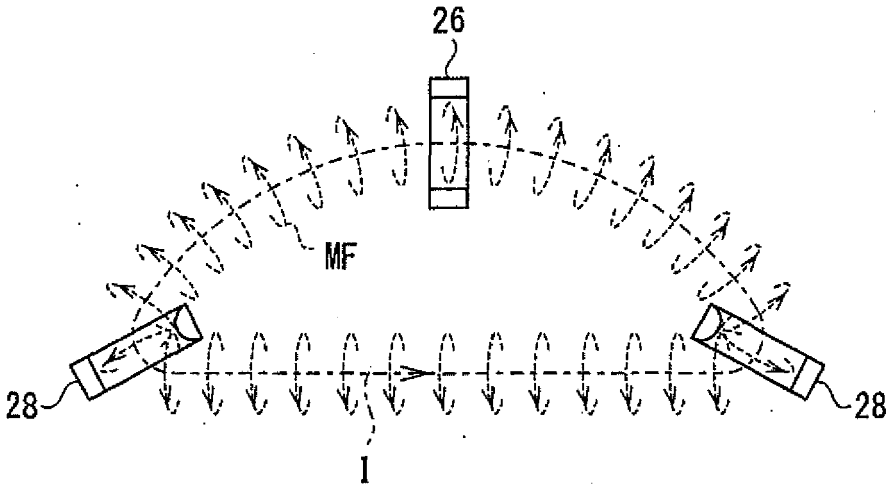


Fig.9

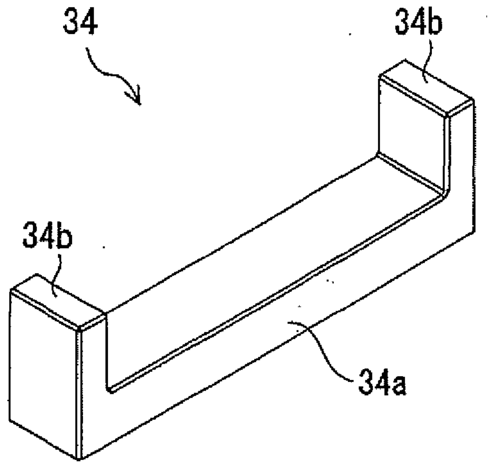

34
34b
34b
34a

Fig.10A

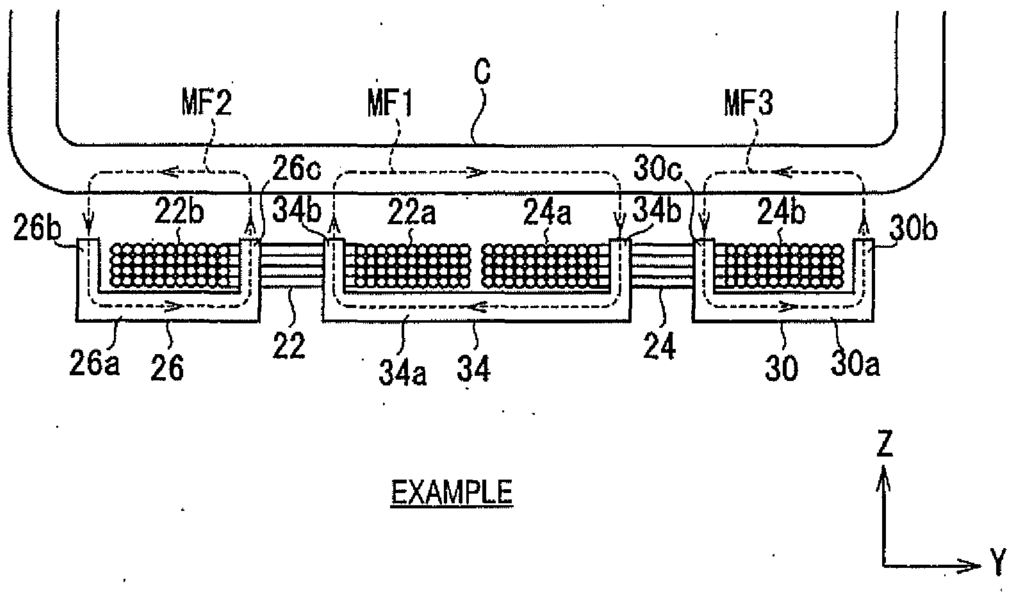
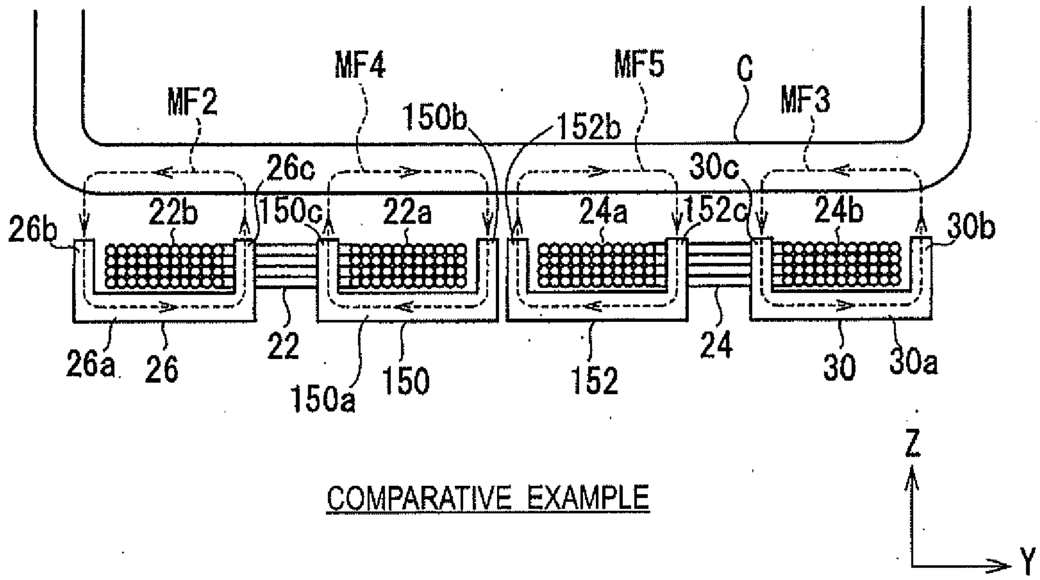
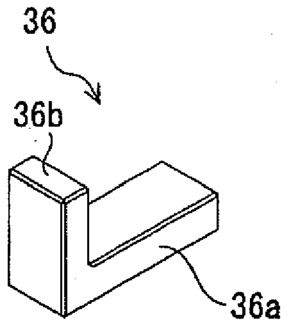

C
MF2
MF1
MF3
26c
30c
26b
22b
34b
22a
24a
34b
24b
30b
26a
26
22
34a
34
24
30
30a
EXAMPLE
Z
Y

Fig.10B



COMPARATIVE EXAMPLE

Fig.11



Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 19 17 7673

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	FR 2 657 486 A1 (BONNET SA [FR]) 26 July 1991 (1991-07-26) * page 3, lines 24-26; figures 1-3 *	1,2,6,10 1-10	INV. H05B6/12
X Y	JP 2010 198753 A (MITSUBISHI ELECTRIC CORP) 9 September 2010 (2010-09-09) * figures 9,14 *	1,2,6,10 1-10	
Y	EP 2 207 401 A2 (SAMSUNG ELECTRONICS CO LTD [KR]) 14 July 2010 (2010-07-14) * figure 3 *	1-10	
Y	JP 2010 277866 A (HITACHI APPLIANCES INC) 9 December 2010 (2010-12-09) * figure 7 *	3-5	
A,D	JP H01 246782 A (TOSHIBA CORP) 2 October 1989 (1989-10-02) * figure 7 *	1-10	

TECHNICAL FIELDS SEARCHED (IPC)

H05B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	22 October 2019	Pierron, Christophe

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 17 7673

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

22-10-2019

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 2657486 A1	26-07-1991	NONE	
JP 2010198753 A	09-09-2010	JP 5227832 B2 JP 2010198753 A	03-07-2013 09-09-2010
EP 2207401 A2	14-07-2010	EP 2207401 A2 US 2010176116 A1	14-07-2010 15-07-2010
JP 2010277866 A	09-12-2010	JP 5271810 B2 JP 2010277866 A	21-08-2013 09-12-2010
JP H01246782 A	02-10-1989	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 1246782 A **[0003]**