



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
15.10.2014 Bulletin 2014/42

(51) Int Cl.:
H01J 23/40^(2006.01) H01J 23/12^(2006.01)

(21) Application number: **12855050.6**

(86) International application number:
PCT/JP2012/007827

(22) Date of filing: **06.12.2012**

(87) International publication number:
WO 2013/084497 (13.06.2013 Gazette 2013/24)

(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

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(30) Priority: **06.12.2011 JP 2011266565**

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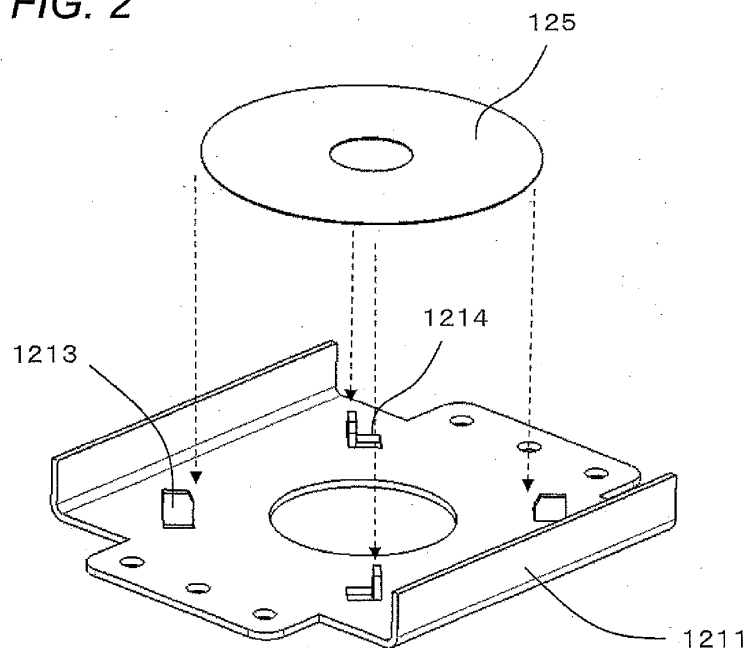
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(54) **MAGNETRON AND MICROWAVE-USING EQUIPMENT**

(57) A magnetron 1 according to the invention is equipped with an anode cylinder 112 having a high-frequency wave output unit 111, permanent magnets 122 disposed on the two respective sides of the anode cylinder, and magnetic yokes 121 which house the anode cylinder and the permanent magnets inside. One, on the high-frequency wave output side, of the magnetic yokes

is formed with a plurality of cut and raised parts 1213. The anode cylinder and the one magnetic yoke are positioned with respect to the fixed to each other by sandwiching a metal plate 125 which matches the high-frequency wave output unit and the cut and raised parts 1213 between one of the permanent magnet and the magnetic yoke.

FIG. 2



Description

Technical Field

[0001] The present invention relates to a magnetron that is suitable for use in microwave oscillation apparatus such as microwave-using apparatus.

Background Art

[0002] Magnetrons are roughly divided into a vacuum tube part and an exterior part. The vacuum tube part includes an anode cylinder whose inner wall surface is provided with a plurality of vanes extending radially, an input unit having a cathode structure disposed on the center axis of the anode cylinder, and a high-frequency wave output unit. The exterior part includes permanent magnets, magnetic yokes which constitute a magnetic circuit, and a cooling unit.

[0003] There are various methods for positioning the vacuum tube part and the exterior part with respect to each other. For example, in the magnetron disclosed in Patent Document 1, as shown in Fig. 10, annular ribs 31 project from the inner surface of a first magnetic yoke 3 which is disposed on the high-frequency wave output side. As shown in Fig. 9, a positioning plate 4 whose outer diameter matches the inner diameter of the annular ribs 31 so that the positioning plate 4 is just fitted in the annular ribs 31 and whose inner diameter matches the outer diameter of the high-frequency wave output unit so that the positioning plate 4 is just fitted with a high-frequency wave output unit is sandwiched between the first magnetic yoke 3 and a permanent magnet 122. The vacuum tube part and the exterior part are positioned with respect to and fixed to each other by the positioning plate 4 interposed in between by fitting the positioning plate 4 into the annular ribs 31 and with the high-frequency wave output unit 111.

[0004] In Patent Document 1, shown in Fig. 9, a cooling unit has a spiral structure and the positioning plate has baffle plates 41 so as to obstruct a cooling wind flowing through ineffective air passages.

Related Art Documents

Patent Documents

[0005] Patent Document 1: JP-A-S59-81834

Summary of the Invention

Problem to be Solved by the Invention

[0006] However, in the above conventional configuration, since the yoke is formed with the ribs, the rib projection height has a limit and assembling is possible even in a state that the positioning plate 4 is not fitted in the annular ribs 31.

[0007] Furthermore, with the structure that the positioning plate 4 has the baffle plates 41, directivity occurs at the time of assembling. As a result, assembling is complicated and a probability is high that the positioning plate 4 goes up onto the annular ribs 31.

[0008] Still further, the ribs which are formed on the yoke have only the function of positioning and fixing the vacuum tube part and the exterior part with respect to each other by the positioning plate 4 interposed in between; no consideration is given to positioning with respect to a waveguide unit of a microwave-using apparatus or the like.

[0009] Therefore, where only general attachment screws are used, the position of the magnetron relative to the waveguide unit varies, raising a problem that discharge may occur between the high-frequency wave output unit and the waveguide unit.

[0010] The present invention has been made in the above circumstances, and an object of the present invention is to provide a magnetron high-frequency wave output unit can be positioned with respect to and fixed to its magnetic yoke and the waveguide unit of a microwave-using apparatus or the like reliably, without complicating its structure or assembling method.

Means for Solving the Problem

[0011] To solve the above problems in the related art, the invention provides a magnetron including: an anode cylinder including a high-frequency wave output unit; permanent magnets disposed on two opposite sides of the anode cylinder, respectively; and a magnetic yoke which houses therein the anode cylinder and the permanent magnets, wherein a portion, on a high-frequency wave output side, of the magnetic yoke is formed with a plurality of cut and raised parts, and a metal plate which matches the high-frequency wave output unit and the cut and raised parts is sandwiched between one of the permanent magnet and the magnetic yoke, whereby the anode cylinder and the magnetic yoke are positioned with respect to and fixed to each other.

[0012] With this configuration, the high-frequency wave output unit of the magnetron can reliably be positioned with respect to and fixed to the magnetic yoke and a waveguide unit of a microwave-using apparatus or the like, without complicating its structure or assembling method.

[0013] In the above magnetron, a waveguide unit, to which the magnetron is attached, of a microwave-using apparatus is formed with a cut and raised part which matches a hole formed by the cut and raised part in the magnetic yoke, and the cut and raised part of the waveguide unit is fitted in the hole of the magnetic yoke, whereby the magnetic yoke and the waveguide unit are positioned with respect to and fixed to each other.

[0014] In the above magnetron, a waveguide unit, to which the magnetron is attached, of a microwave-using apparatus is formed with a projection which matches a

hole formed by the cut and raised part in the magnetic yoke, and the projection of the waveguide unit is fitted in the hole of the magnetic yoke, whereby the magnetic yoke and the waveguide unit are positioned with respect to and fixed to each other.

[0015] In the above magnetron, a waveguide unit, to which the magnetron is attached, of a microwave-using apparatus is formed with a hole which matches the cut and raised part of the magnetic yoke, and the cut and raised part of the magnetic yoke is fitted in the hole of the waveguide unit, whereby the magnetic yoke and the waveguide unit are positioned with respect to and fixed to each other.

[0016] With the above structures, the height of the cut and raised parts can be set freely and hence deviation of the positioning metal plate can be suppressed.

[0017] Since the plurality of cut and raised parts are formed, the positioning metal plate need not have directivity and is given a simple structure, which facilitates assembling.

[0018] The magnetic yoke and the waveguide unit are positioned with respect to and fixed to each other because of the structure that the cut and raised parts formed in the magnetic yoke are fitted in the respective holes formed in the waveguide unit or the cut and raised parts or the projections formed in the waveguide unit of the microwave-using apparatus are fitted in the respective holes formed by the cut and raised parts in the magnetic yoke. As a result, the high-frequency output unit and the waveguide unit are positioned with respect to and fixed to each other, whereby discharge between the high-frequency output unit and the waveguide unit can be suppressed.

[0019] The invention also provides a magnetron including: an anode cylinder including a high-frequency wave output unit; permanent magnets disposed on two opposite sides of the anode cylinder, respectively; and a magnetic yoke which houses therein the anode cylinder and the permanent magnets, wherein a portion, on a high-frequency wave output side, of the magnetic yoke is formed with a plurality of holes, a metal plate which matches the high-frequency wave output unit and the holes is sandwiched between one of the permanent magnet and the magnetic yoke, and positioning rods are inserted in the respective holes, whereby the anode cylinder and the magnetic yoke are positioned with respect to and fixed to each other.

[0020] In the above magnetron, a waveguide unit, to which the magnetron is attached, of a microwave-using apparatus is formed with holes which match the respective holes of the magnetic yoke, and the magnetic yoke and the waveguide unit are positioned with respect to and fixed to each other by the positioning rods.

[0021] With the above structures, the positioning rods can be set freely and hence deviation between the positioning metal plate and the magnetic yoke can be suppressed.

[0022] Since the positioning rods are inserted in the

respective holes, the positioning metal plate need not have directivity and is given a simple structure, which facilitates assembling.

[0023] The metal plate, the magnetic yoke, and the waveguide unit are positioned with respect to and fixed to each other by the positioning rods. As a result, the high-frequency output unit and the waveguide unit are positioned with respect to and fixed to each other, whereby discharge between the high-frequency output unit and the waveguide unit can be suppressed.

[0024] By applying the above-described magnetron to a microwave-using apparatus, the microwave-using apparatus with can be more stable and enhanced in performance.

Advantages of the Invention

[0025] The magnetron and the microwave-using apparatus according to the invention make it possible to reliably positioning and fixing the high-frequency wave output unit of the magnetron with respect to and to a magnetic yoke of the magnetron and the waveguide unit of a microwave-using apparatus or the like, without complicating their structures or assembling methods.

Brief Description of the Drawings

[0026]

Fig. 1 is a front view of a magnetron according to a first embodiment of the present invention.

Fig. 2 is a perspective view of a magnetic yoke and a metal plate of the magnetron according to the first embodiment of the invention.

Fig. 3 is a partially sectional view of a magnetron with a waveguide unit according to the first embodiment of the invention.

Fig. 4 is a perspective view of a magnetic yoke of a magnetron according to a second embodiment of the invention.

Fig. 5 is a partially sectional view of a magnetron with a waveguide unit according to the second embodiment of the invention.

Fig. 6 is a front view of a magnetron according to a third embodiment of the invention.

Fig. 7 is a perspective view of a rod of the magnetron according to the third embodiment of the invention.

Fig. 8 is a partially sectional view of a magnetron with a waveguide unit according to the third embodiment of the invention.

Fig. 9 is a front view of a conventional magnetron.

Fig. 10 is a perspective view of a magnetic yoke and a positioning plate of the conventional magnetron.

Mode for Carrying Out the invention

[0027] A first invention provides a magnetron including: an anode cylinder including a high-frequency wave

output unit; permanent magnets disposed on two opposite sides of the anode cylinder, respectively; and a magnetic yoke which houses therein the anode cylinder and the permanent magnets, wherein a portion, on a high-frequency wave output side, of the magnetic yoke is formed with a plurality of cut and raised parts, and a metal plate which matches the high-frequency wave output unit and the cut and raised parts is sandwiched between one of the permanent magnet and the magnetic yoke, whereby the anode cylinder and the magnetic yoke are positioned with respect to and fixed to each other. With this configuration, the high-frequency wave output unit of the magnetron can reliably be positioned with respect to and fixed to the magnetic yoke and a waveguide unit of a microwave-using apparatus, without complicating its structure or assembling method, and the assembling can be facilitated by the simplified structure.

[0028] A second invention provides the magnetron of the first invention, particularly, wherein a waveguide unit, to which the magnetron is attached, of a microwave-using apparatus is formed with a cut and raised part which matches a hole formed by the cut and raised part in the magnetic yoke, and the cut and raised part of the waveguide unit is fitted in the hole of the magnetic yoke, whereby the magnetic yoke and the waveguide unit are positioned with respect to and fixed to each other. With this configuration, a variation in a relative position of the high-frequency wave output unit and the waveguide unit can be suppressed, and occurrence of discharge between the high-frequency wave output unit and the waveguide unit can be suppressed.

[0029] A third invention provides the magnetron of the first invention, particularly, wherein a waveguide unit, to which the magnetron is attached, of a microwave-using apparatus is formed with a projection which matches a hole formed by the cut and raised part in the magnetic yoke, and the projection of the waveguide unit is fitted in the hole of the magnetic yoke, whereby the magnetic yoke and the waveguide unit are positioned with respect to and fixed to each other. With this configuration, a variation in a relative position of the high-frequency wave output unit and the waveguide unit can be suppressed, and occurrence of discharge between the high-frequency wave output unit and the waveguide unit can be suppressed.

[0030] A fourth invention provides the magnetron of the first invention, particularly, wherein a waveguide unit, to which the magnetron is attached, of a microwave-using apparatus is formed with a hole which matches the cut and raised part of the magnetic yoke, and the cut and raised part of the magnetic yoke is fitted in the hole of the waveguide unit, whereby the magnetic yoke and the waveguide unit are positioned with respect to and fixed to each other. With this configuration, a variation in a relative position of the high-frequency wave output unit and the waveguide unit can be suppressed, and occurrence of discharge between the high-frequency wave output unit and the waveguide unit can be suppressed.

[0031] A fifth invention provides a magnetron including: an anode cylinder including a high-frequency wave output unit; permanent magnets disposed on two opposite sides of the anode cylinder, respectively; and a magnetic yoke which houses therein the anode cylinder and the permanent magnets, wherein a portion, on a high-frequency wave output side, of the magnetic yoke is formed with a plurality of holes, a metal plate which matches the high-frequency wave output unit and the holes is sandwiched between one of the permanent magnet and the magnetic yoke, and positioning rods are inserted in the respective holes, whereby the anode cylinder and the magnetic yoke are positioned with respect to and fixed to each other. With this configuration, the high-frequency wave output unit of the magnetron can reliably be positioned with respect to and fixed to the magnetic yoke and a waveguide unit of a microwave-using apparatus, without complicating its structure or assembling method, and the assembling can be facilitated by the simplified structure.

[0032] A sixth invention provides the magnetron of the fifth invention, particularly, wherein a waveguide unit, to which the magnetron is attached, of a microwave-using apparatus is formed with holes which match the respective holes of the magnetic yoke, and the magnetic yoke and the waveguide unit are positioned with respect to and fixed to each other by the positioning rods. With this configuration, a variation in a relative position of the high-frequency wave output unit and the waveguide unit can be suppressed, and occurrence of discharge between the high-frequency wave output unit and the waveguide unit can be suppressed.

[0033] A seventh invention provides a microwave-using apparatus including the magnetron according to any one of the first to sixth inventions, which can be more stable and enhanced in performance

[0034] Embodiments of the invention will be hereinafter described with reference to the drawings. The embodiments should not be construed as restricting the invention.

(Embodiment 1)

[0035] Fig. 1 is a front view of a magnetron according to a first embodiment of the invention. Fig. 2 is a perspective view of a magnetic yoke and a metal plate of the magnetron according to the first embodiment of the invention.

[0036] As shown in Fig. 1, the magnetron 1 includes a vacuum tube part 11 and an exterior part 12. The vacuum tube part 11 includes an anode cylinder 112, an input unit (not shown), and a high-frequency wave output unit 111. The exterior part includes permanent magnets 122, magnetic yokes 121 which constitute a magnetic circuit, a cooling unit 123 including a plurality of cooling fins, and a filter unit 124 for supplying power to the input unit.

[0037] The magnetic yokes 121 includes a first magnetic yoke 1211 disposed on the high-frequency wave

output side and a second magnetic yoke 1212 disposed on the filter side which are connected to each other by caulking.

[0038] A metal plate 125 is as thick as about 30% of the magnetic yokes 121, and is sandwiched between the permanent magnet 122 and the first magnetic yoke 1211. A gasket 126 is held and leakage of radio waves to be are output from the high-frequency wave output unit 111 is prevented.

[0039] As shown in Fig. 2, the first magnetic yoke 1211 is formed with four cut and raised parts 1213 having a height that is about three times the thickness of the magnetic yokes 121 at ineffective air passage portions of a cooling wind so as to project toward the inside of the magnetic yokes and to be arranged radially and symmetrically so as to have no directivity. The cut and raised parts 1213 are formed so as to just fit with the metal plate 125 whose outer diameter is approximately equal to the diameter of the circle that inscribes their end faces.

[0040] The metal plate 125 is formed in such a manner that its inner diameter of the is approximately equal to the outer diameter of the high-frequency wave output unit 111 of the vacuum tube part 11 so that the metal plate 125 just fits with the high-frequency wave output unit 111.

[0041] With the above structures, the vacuum tube part 11 is positioned with respect to the first magnetic yoke 1211 with the metal plate 125 interposed in between because an inside portion (in the radial direction) of the metal plate 125 is fitted with the high-frequency wave output unit 111 and an outside portion (in the radial direction) of the metal plate 125 is fitted in the circle that inscribes the end faces of the cut and raised parts 1213 of the first magnetic yoke 1211.

[0042] The first magnetic yoke 1211 has holes 1214 as a result of the formation of the respective cut and raised parts 1213.

[0043] Fig. 3 is a partially sectional view of a magnetron with a waveguide unit according to the first embodiment of the invention.

[0044] As shown in Fig. 3, a portion, to which the magnetron 1 is to be attached, of a waveguide unit 2 is formed with four cut and raised parts 21 having a height that is about two times the thickness of the magnetic yokes 121 at such positions as to fit into the respective holes 1214 formed by the cut and raised parts 1213 of the first magnetic yoke 1211 so as to project toward the outside of the waveguide unit 2. The cut and raised parts 21 of the waveguide unit 2 are partially fitted in the respective holes 1214 formed by the cut and raised parts 1213 of the first magnetic yoke 1211.

[0045] With this structure, the magnetron 1 and the waveguide unit 2 are positioned with respect to each other and the first magnetic yoke 1211 and the waveguide unit 2 are fixed to each other with screws.

[0046] How the above-configured magnetron works will be described below.

[0047] First, shaped like a disc, the metal plate 125 has no directivity and enables simple assembling. Since

the height of the cut and raised parts 1213 is sufficiently greater than the thickness of the metal plate 125, the metal plate 125 never goes up onto the cut and raised parts 1213.

[0048] Since the vacuum tube part 11 of the magnetron 1 is positioned with respect to the first magnetic yoke 1211 with the metal plate 125 interposed in between, positional variations of members involved can be reduced at the time of assembling and deviations can be suppressed when the magnetron 1 is subjected to vibration or impact.

[0049] Furthermore, since the magnetron 1 is positioned with respect to and fixed to the waveguide unit 2, deviations of the high-frequency wave output unit 111 with respect to the waveguide unit 2 can be suppressed to a large extent, whereby the occurrence of discharge between the high-frequency wave output unit 111 and the waveguide unit 2 can be suppressed and radio waves can be guided reliably.

[0050] Still further, since the cut and raised parts 1213 are formed at ineffective air passage portions of a cooling wind, they also serve as baffle plates, making it possible to apply a cooling wind to the cooling fins efficiently.

[0051] After hitting the cut and raised parts 1213, parts of a cooling wind flow through the holes 1214 formed by the cut and raised parts 1213 and flow into the waveguide unit through the holes 22 formed by the cut and raised parts 21 of the waveguide unit 2, to produce a convectional air flow in the waveguide unit. It is therefore expected that the occurrence of discharge between the high-frequency wave output unit 111 and the waveguide unit 2 can be suppressed further.

[0052] It is preferable that an even number of cut and raised parts be arranged symmetrically so as not to have directivity. However, the number, size, positions, shape, directions, and angle of the cut and raised parts are not restricted at all as long as they enable positioning with respect to the metal plate and the waveguide unit.

[0053] The cut and raised parts for positioning of the metal plate and those for positioning of the waveguide unit may be formed separately.

[0054] Although it is preferable that the metal plate have such a simple structure as not to have directivity, the metal plate may have any structure as long as it can be positioned with respect to the yokes.

(Embodiment 2)

[0055] Fig. 4 is a perspective view of a magnetic yoke of a magnetron according to a second embodiment of the invention. Fig. 5 is a partially sectional view of a magnetron with a waveguide unit according to the same embodiment.

[0056] As shown in Fig. 4, a first magnetic yoke 1215 is formed with four first cut and raised parts 1216 having a height that is about three times the thickness of the magnetic yokes at ineffective air passage portions of a cooling wind so as to project toward the inside of the

magnetic yokes and to be arranged radially and symmetrically so as to have no directivity. The first cut and raised parts 1216 are formed so as to just fit with the metal plate 125 whose outer diameter is approximately equal to the diameter of the circle that inscribes their end faces.

[0057] The first magnetic yoke 1215 is formed with two second cut and raised parts 1217 having a height that is about two times the thickness of the magnetic yokes so as to project toward the outside of the magnetic yokes and to be arranged radially and symmetrically so as to have no directivity.

[0058] The first magnetic yoke 1215 has holes 1214 as a result of the formation of the respective first cut and raised parts 1216.

[0059] The magnetron is configured in the same manner as in the first embodiment except for the first magnetic yoke 1215.

[0060] With the above structures, the vacuum tube part 11 is positioned with respect to the first magnetic yoke 1215 with the metal plate 125 interposed in between because an inside portion (in the radial direction) of the metal plate 125 is fitted with the high-frequency wave output unit 111 and an outside portion (in the radial direction) of the metal plate 125 is fitted in the circle that inscribes the end faces of the cut and raised parts 1215 of the first magnetic yoke 1215.

[0061] As shown in Fig. 5, a portion, to which the magnetron 1 is to be attached, of the waveguide unit 2 is formed with first holes 23 at such positions as to be fitted with the respective second cut and raised parts 1217 of the first magnetic yoke 1215.

[0062] Furthermore, the portion, to which the magnetron 1 is to be attached, of the waveguide unit 2 is formed with second holes 24 at the same positions as the respective holes 1214 formed by the first cut and raised parts 1216 of the first magnetic yoke 1215. The second cut and raised parts 1217 of the first magnetic yoke 1215 are partially fitted in the respective first holes 23 of the waveguide unit 2.

[0063] With this structure, the magnetron 1 and the waveguide unit 2 are positioned with respect to each other and the first magnetic yoke 1215 and the waveguide unit 2 are fixed to each other with screws.

[0064] How the above-configured magnetron works will be described below.

[0065] First, shaped like a disc, the metal plate 125 has no directivity and enables simple assembling.

[0066] Since the height of the first cut and raised parts 1216 is sufficiently greater than the thickness of the metal plate 125, the metal plate 125 never goes up onto the first cut and raised parts 1216.

[0067] Since the vacuum tube part 11 of the magnetron 1 is positioned with respect to the first magnetic yoke 1215 with the metal plate 125 interposed in between, positional variations of members involved can be reduced at the time of assembling and deviations can be suppressed when the magnetron 1 is subjected to vibration or impact.

[0068] Furthermore, since the magnetron 1 is positioned with respect to and fixed to the waveguide unit 2, deviations of the high-frequency wave output unit 111 with respect to the waveguide unit 2 can be suppressed to a large extent, whereby the occurrence of discharge between the high-frequency wave output unit 111 and the waveguide unit 2 can be suppressed and radio waves can be guided reliably.

[0069] Still further, since the first cut and raised parts 1216 are formed at ineffective air passage portions of a cooling wind, they also serve as baffle plates, making it possible to apply a cooling wind to the cooling fins efficiently.

[0070] After hitting the first cut and raised parts 1216, parts of a cooling wind flow through the holes 1214 formed by the first cut and raised parts 1216 and flow into the waveguide unit through the second holes 24 of the waveguide unit 2, to produce a convectional air flow in the waveguide unit. It is therefore expected that the occurrence of discharge between the high-frequency wave output unit 111 and the waveguide unit 2 can be suppressed further.

[0071] It is preferable that an even number of cut and raised parts be arranged symmetrically so as not to have directivity. However, the number, size, positions, shape, directions, and angle of the cut and raised parts are not restricted at all as long as they enable positioning with respect to the metal plate and the waveguide unit.

[0072] Although it is preferable that the metal plate have such a simple structure as not to have directivity, it may have any structure as long as it can be positioned with respect to the yokes.

[0073] It is preferable that for the purpose of air convection the waveguide unit 2 be formed with holes other than those for the relative positioning. However, the number, positions, and shape of the holes are not restricted at all as long as they make it possible to position the waveguide unit with respect to the magnetron.

(Embodiment 3)

[0074] Fig. 6 is a front view of a magnetron according to a third embodiment of the invention. Fig. 7 is a perspective view of a rod of the magnetron according to the third embodiment of the invention.

[0075] As shown in Fig. 6, a first magnetic yoke 1218 is formed with four holes 1219 approximately on the outer circumference of the metal plate 125 at ineffective air passage portions of a cooling wind so as to be arranged radially and symmetrically so as to have no directivity.

[0076] Rods 127 are inserted through the four respective holes 1219 of the first magnetic yoke 1218 so as to project by approximately the same length inward and outward.

[0077] As shown in Fig. 7, each rod 127 has a semi-cylindrical shape and has a length that is about five times the thickness of the magnetic yokes. The rods 127 are press-fitted in the respective holes 1219 of the first mag-

netic yoke 1218.

[0078] The rods 127 are made of aluminum.

[0079] The metal plate 125 is fitted in the circle that inscribes the circular arcs of the four rods 127, and is thereby positioned with respect to the first magnetic yoke 1218.

[0080] The magnetron is configured in the same manner as in the first embodiment except for the first magnetic yoke 1218 and the rods 127.

[0081] With the above structures, the vacuum tube part 11 is positioned with respect to the first magnetic yoke 1218 with the metal plate 125 interposed in between because an inside portion (in the radial direction) of the metal plate 125 is fitted with the high-frequency wave output unit 111 and an outside portion (in the radial direction) of the metal plate 125 is fitted in the circle that inscribes the circular arcs of the rods 127 which are press-fitted in the first magnetic yoke 1218.

[0082] Fig. 8 is a partially sectional view of a magnetron with a waveguide unit according to the third embodiment of the invention.

[0083] As shown in Fig. 8, a portion, to which the magnetron 1 is to be attached, of the waveguide unit 2 is formed with holes 25 at such positions as to fit with the respective rods 127 which are press-fitted in the first magnetic yoke 1218. The rods 127 are fitted in the respective holes 25 of the waveguide unit 2.

[0084] With this structure, the magnetron 1 and the waveguide unit 2 are positioned with respect to each other and the first magnetic yoke 1215 and the waveguide unit 2 are fixed to each other with screws.

[0085] How the above-configured magnetron works will be described below.

[0086] First, shaped like a disc, the metal plate 125 has no directivity and enables simple assembling. Since the height of the rods 127 is sufficiently greater than the thickness of the metal plate 125, the metal plate 125 never goes up onto the rods 127.

[0087] Since the rods 127 are not magnetic, the magnetic loss can be suppressed. Since the vacuum tube part 11 of the magnetron 1 is positioned with respect to the first magnetic yoke 1218 via the metal plate 125 and the rods 127, positional variations of members involved can be reduced at the time of assembling and deviations can be suppressed when the magnetron 1 is subjected to vibration or impact.

[0088] Furthermore, since the magnetron 1 is positioned with respect to and fixed to the waveguide unit 2, deviations of the high-frequency wave output unit 111 with respect to the waveguide unit 2 can be suppressed to a large extent, whereby the occurrence of discharge between the high-frequency wave output unit 111 and the waveguide unit 2 can be suppressed and radio waves can be guided reliably.

[0089] Still further, since the rods 127 project at ineffective air passage portions of a cooling wind, they also serve as baffle plates, making it possible to apply a cooling wind to the cooling fins efficiently.

[0090] What is more, since the rods 127 have a semi-cylindrical shape, after hitting the rods 127 parts of a cooling wind flow through the holes defined by the holes 1219 and the rods 127 and flow into the waveguide unit through holes defined by the holes 25 of the waveguide unit 2 and the rods 127, to produce a convectional air flow in the waveguide unit. It is therefore expected that the occurrence of discharge between the high-frequency wave output unit 111 and the waveguide unit 2 can be suppressed further.

[0091] It is preferable that an even number of rods be arranged symmetrically so as not to have directivity. However, the number, size, positions, shape, and directions of the rods are not restricted at all as long as they enable positioning with respect to the metal plate and the waveguide unit.

[0092] The rods 127 need not be press-fitted as long as they enable positioning with respect to the metal plate and the waveguide unit.

[0093] Although it is preferable that the metal plate have such a simple structure as not to have directivity, it may have any structure as long as it can be positioned with respect to the yokes.

[0094] To suppress the magnetic loss, it is preferable that the rods be made of a non-magnetic material. However, the rods may be made of any material as long as they enable positioning with respect to the metal plate and the waveguide unit.

[0095] Although the invention has been described in detail by referring to the particular embodiments, it is apparent to those skilled in the art that various changes and modifications are possible without departing from the spirit and scope of the invention.

[0096] The present application is based on Japanese Patent Application No. 2011-266565 filed on December 6, 2011, the disclosure of which is incorporated herein by reference.

Industrial Applicability

[0097] The magnetron and the microwave-using apparatus according to the invention make it possible to reliably positioning and fixing the high-frequency wave output unit of the magnetron with respect to and to a magnetic yoke of the magnetron and the waveguide unit of a microwave-using apparatus or the like, to suppress discharge between the high-frequency wave output unit and the waveguide unit, to guide radio waves reliably, without complicating their structures or assembling methods. As such, they can be applied to or used as microwave-using apparatus such as microwave ovens.

Description of Reference Signs

[0098]

1: Magnetron

11: Vacuum Tube Part

111: High-Frequency Wave Output Unit
 112: Anode Cylinder
 12: Exterior Part
 121: Magnetic Yokes
 1211: First magnetic Yoke
 1212: Second magnetic Yoke
 1213: Cut and raised part
 1214: Hole
 1215: First magnetic yoke
 1216: First Cut and Raised Part
 1217: Second Cut and Raised Part
 1218: First magnetic yoke
 1219: Hole
 122: Permanent magnet
 123: Cooling Unit
 124: Filter Unit
 125: Metal Plate
 126: Gasket
 127: Rod
 2: Waveguide Unit
 21: Cut and Raised Part
 22: Hole
 23: First Hole
 24: Second Hole
 25: Hole
 3: First Magnetic Yoke
 31: Annular Rib
 4: Positioning Plate
 41: Baffle Plate

Claims

1. A magnetron comprising:

an anode cylinder comprising a high-frequency wave output unit;
 permanent magnets disposed on two opposite sides of the anode cylinder, respectively; and
 a magnetic yoke which houses therein the anode cylinder and the permanent magnets,
 wherein a portion, on a high-frequency wave output side, of the magnetic yoke is formed with a plurality of cut and raised parts, and a metal plate which matches the high-frequency wave output unit and the cut and raised parts is sandwiched between one of the permanent magnet and the magnetic yoke, whereby the anode cylinder and the magnetic yoke are positioned with respect to and fixed to each other.

2. The magnetron according to claim 1, wherein a waveguide unit, to which the magnetron is attached, of a microwave-using apparatus is formed with a cut and raised part which matches a hole formed by the cut and raised part in the magnetic yoke, and the cut and raised part of the waveguide unit is fitted in the hole of the magnetic yoke, whereby

the magnetic yoke and the waveguide unit are positioned with respect to and fixed to each other.

3. The magnetron according to claim 1, wherein a waveguide unit, to which the magnetron is attached, of a microwave-using apparatus is formed with a projection which matches a hole formed by the cut and raised part in the magnetic yoke, and the projection of the waveguide unit is fitted in the hole of the magnetic yoke, whereby the magnetic yoke and the waveguide unit are positioned with respect to and fixed to each other.

4. The magnetron according to claim 1, wherein a waveguide unit, to which the magnetron is attached, of a microwave-using apparatus is formed with a hole which matches the cut and raised part of the magnetic yoke, and the cut and raised part of the magnetic yoke is fitted in the hole of the waveguide unit, whereby the magnetic yoke and the waveguide unit are positioned with respect to and fixed to each other.

5. A magnetron comprising:

an anode cylinder comprising a high-frequency wave output unit;
 permanent magnets disposed on two opposite sides of the anode cylinder, respectively; and
 a magnetic yoke which houses therein the anode cylinder and the permanent magnets,
 wherein a portion, on a high-frequency wave output side, of the magnetic yoke is formed with a plurality of holes, a metal plate which matches the high-frequency wave output unit and the holes is sandwiched between one of the permanent magnet and the magnetic yoke, and positioning rods are inserted in the respective holes, whereby the anode cylinder and the magnetic yoke are positioned with respect to and fixed to each other.

6. The magnetron according to claim 5, wherein a waveguide unit, to which the magnetron is attached, of a microwave-using apparatus is formed with holes which match the respective holes of the magnetic yoke, and the magnetic yoke and the waveguide unit are positioned with respect to and fixed to each other by the positioning rods.

7. A microwave-using apparatus comprising the magnetron according to any one of claims 1 to 6.

FIG. 1

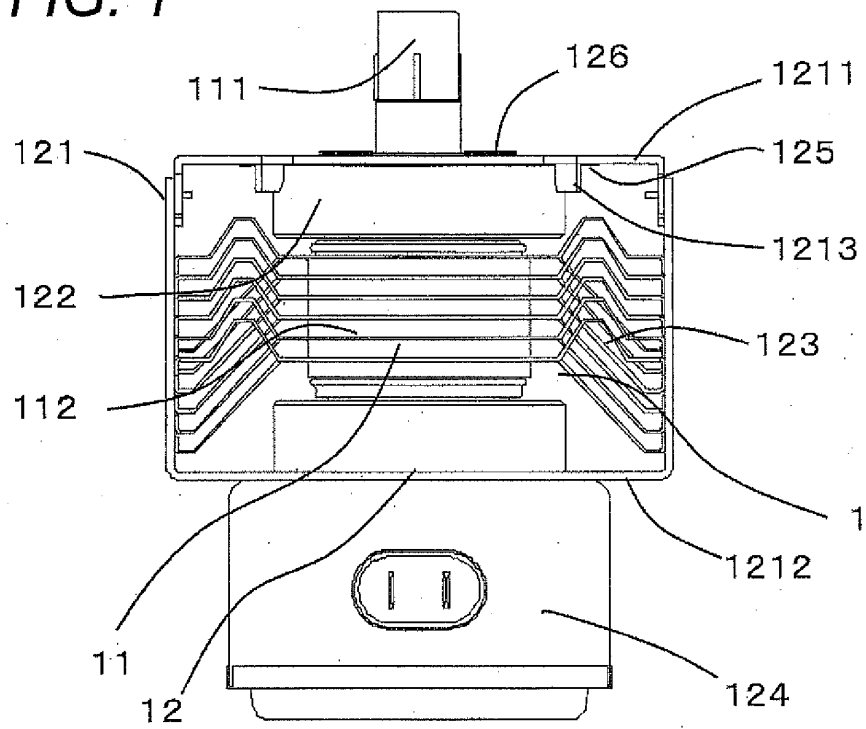


FIG. 2

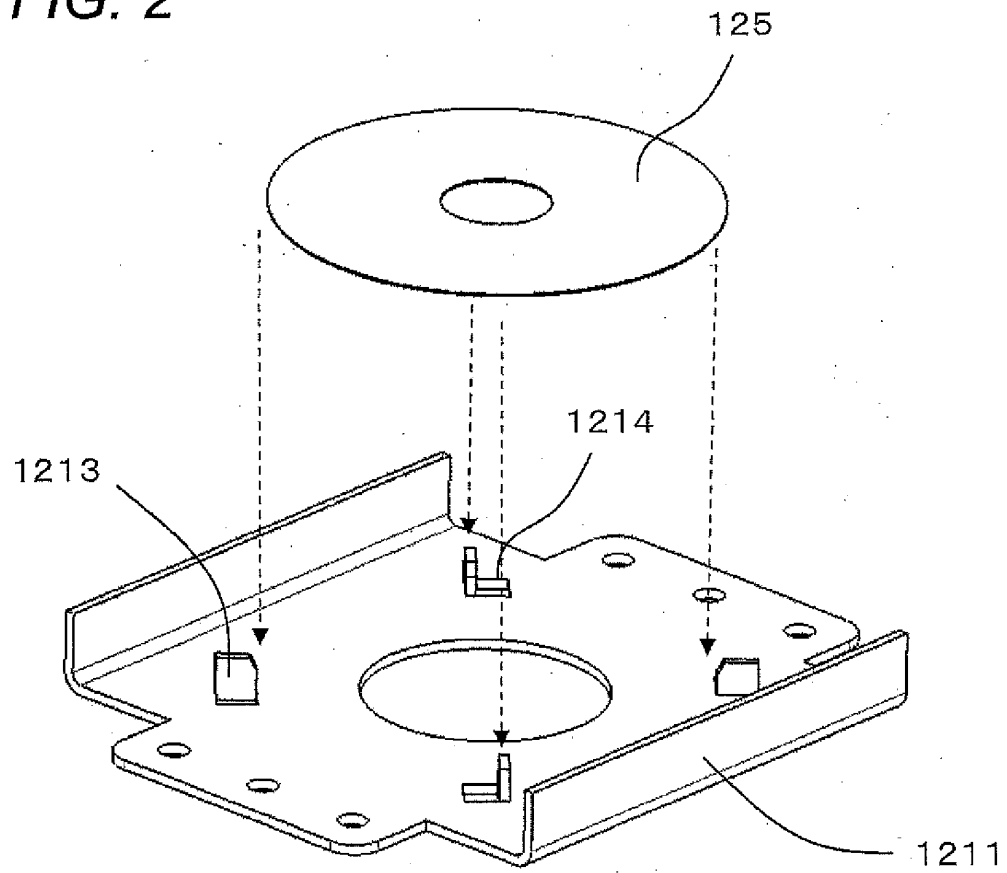


FIG. 3

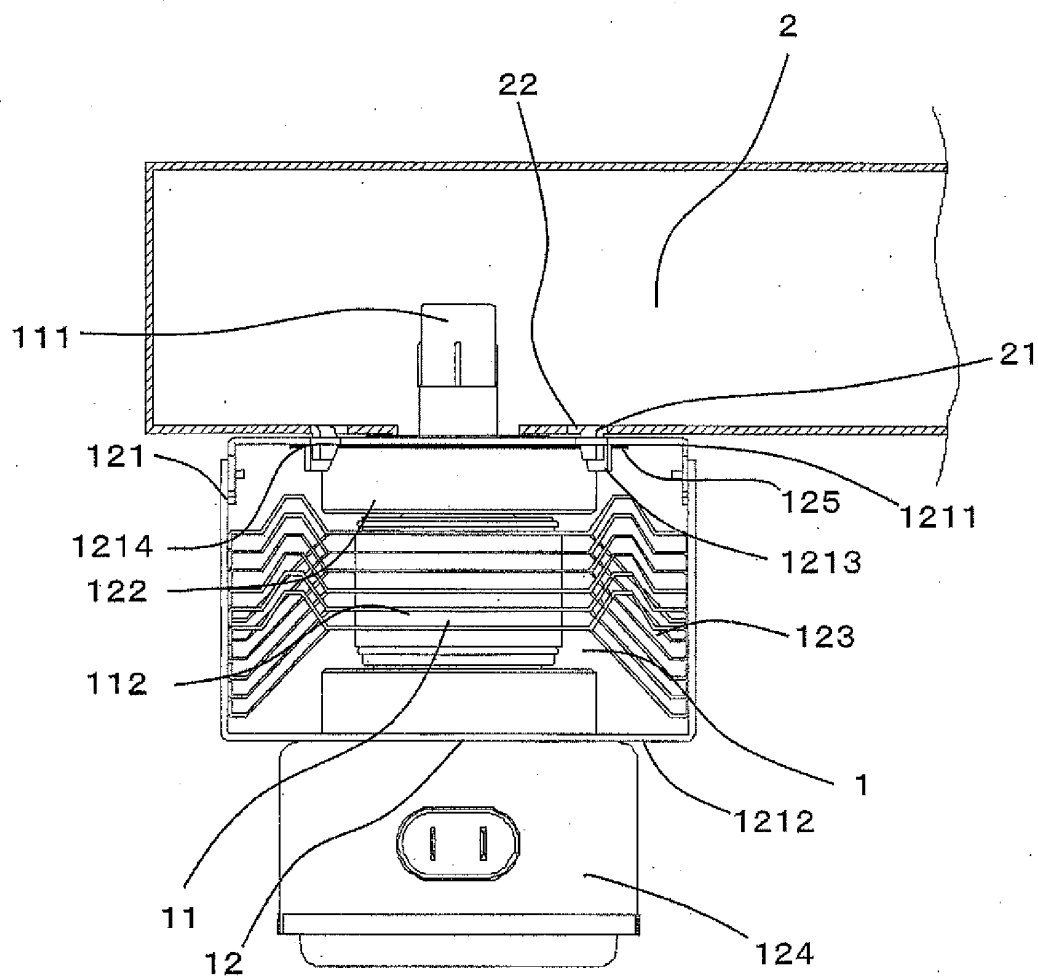


FIG. 4

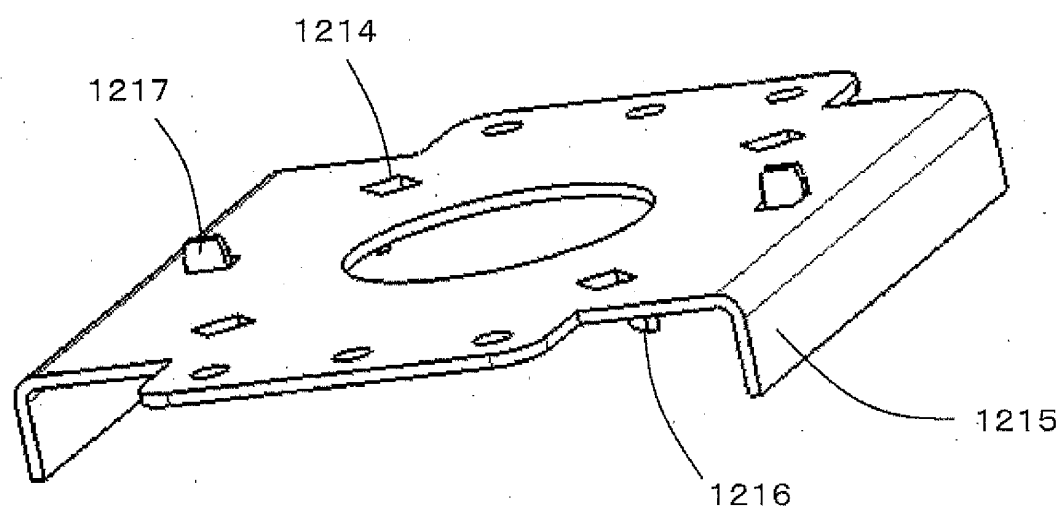


FIG. 5

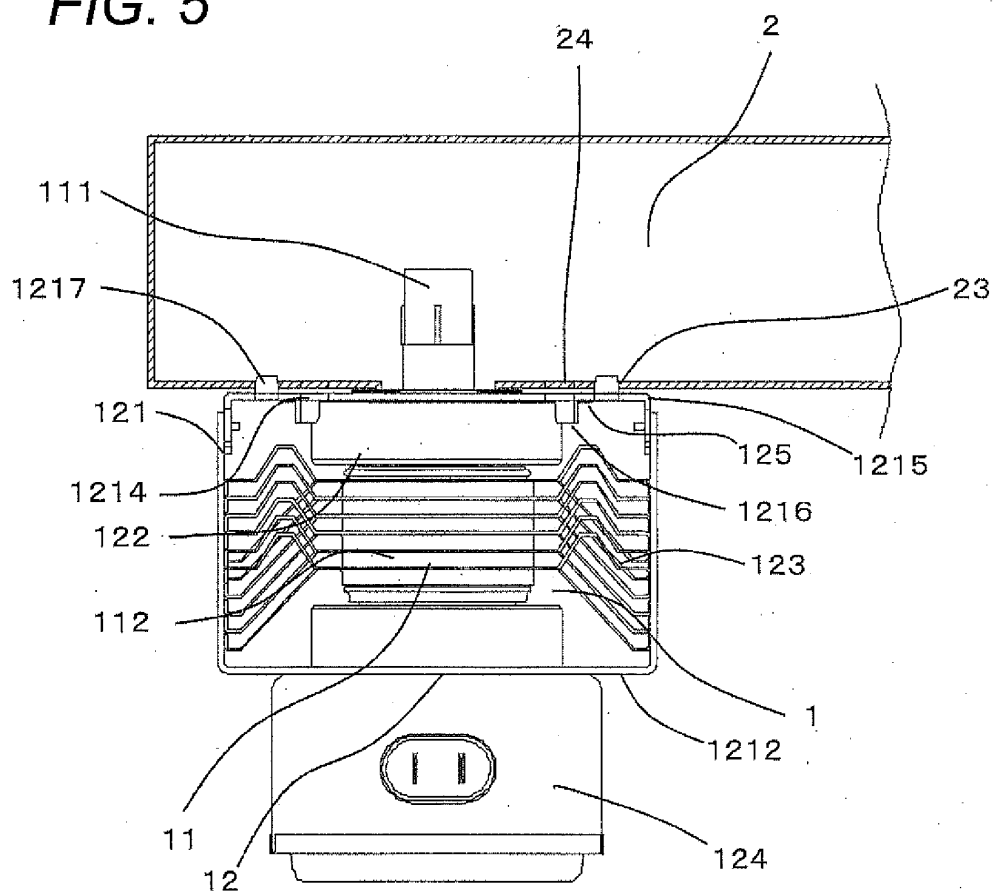


FIG. 6

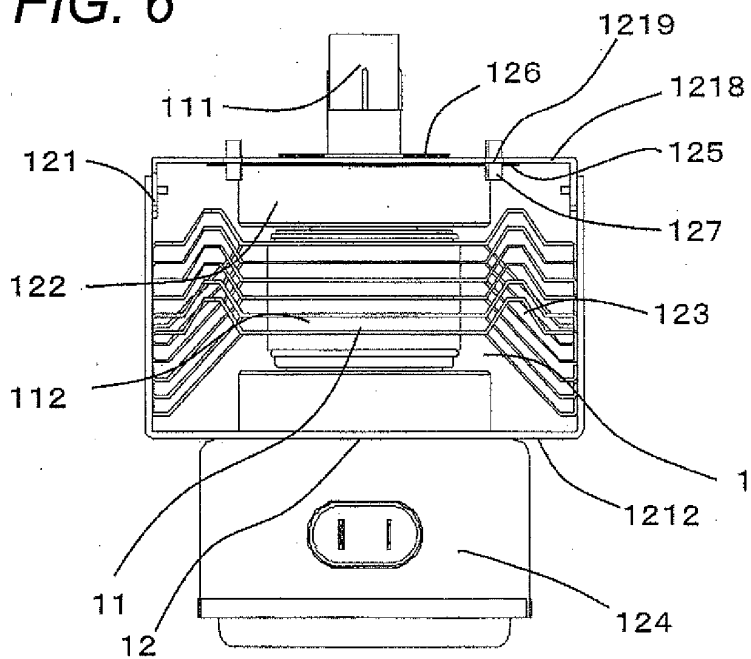


FIG. 7

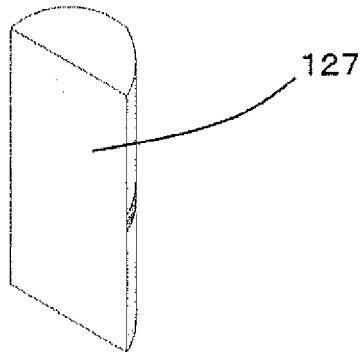


FIG. 8

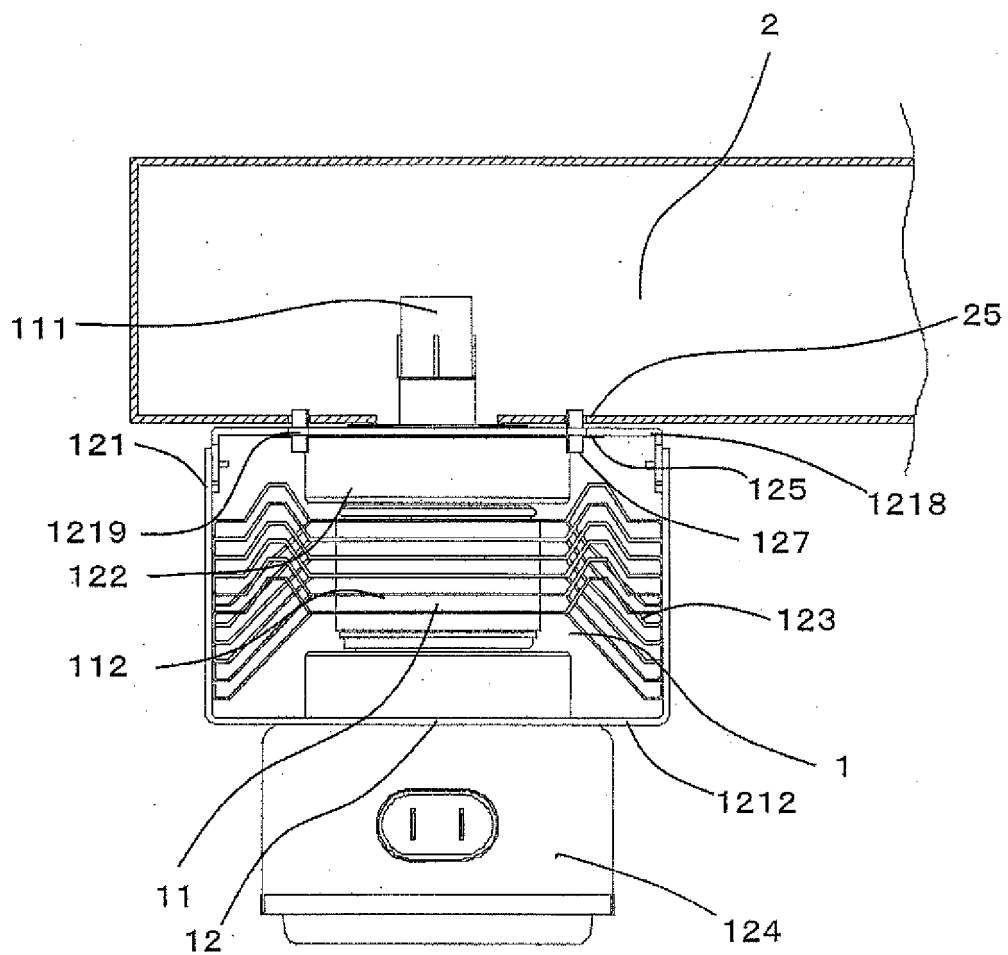


FIG. 9

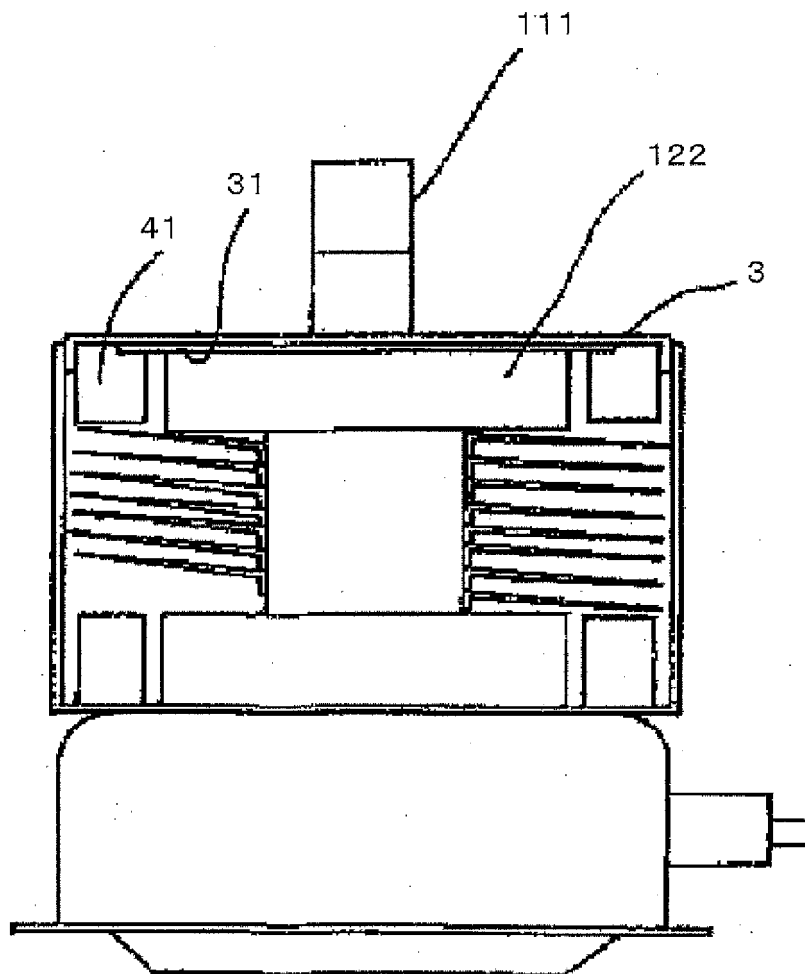
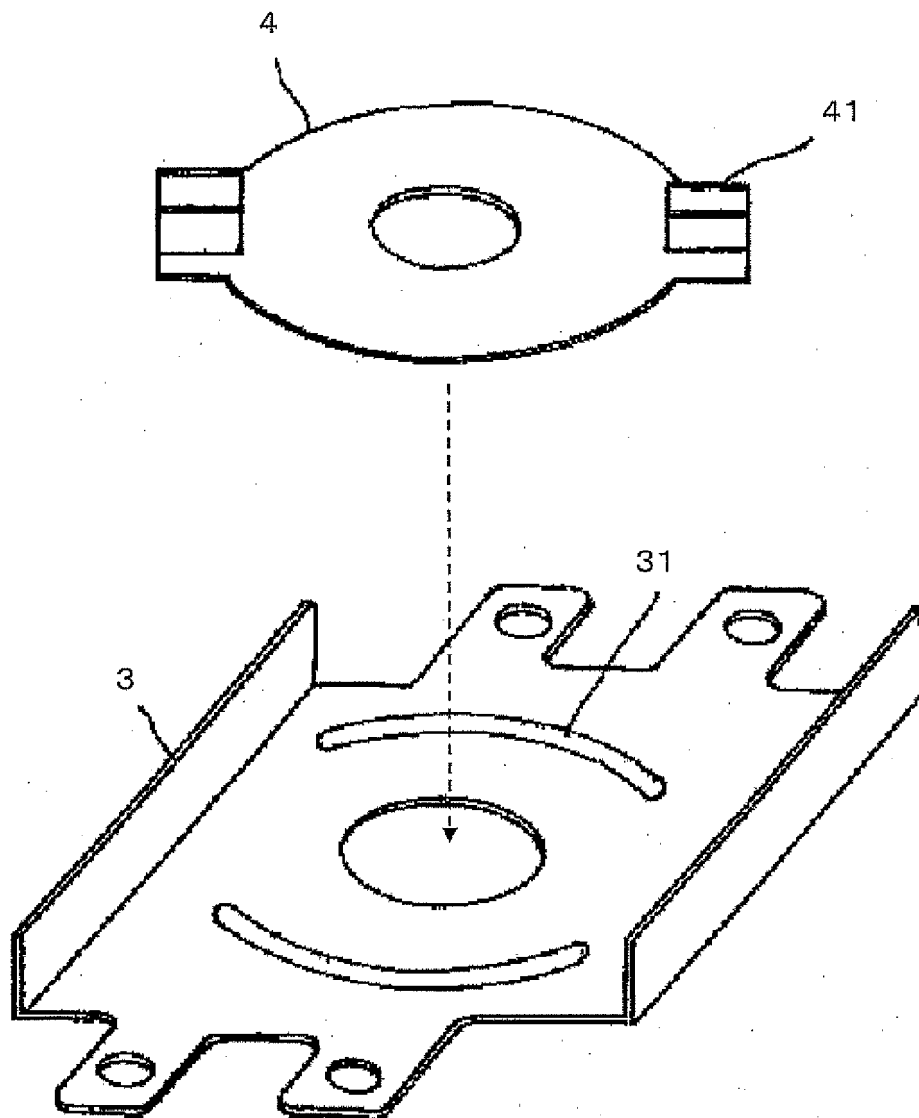


FIG. 10



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/007827

A. CLASSIFICATION OF SUBJECT MATTER

H01J23/40 (2006.01) i, H01J23/12 (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)

H01J23/40, H01J23/12

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2013
Kokai Jitsuyo Shinan Koho	1971-2013	Toroku Jitsuyo Shinan Koho	1994-2013

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 076530/1982 (Laid-open No. 178264/1983) (Tokyo Shibaura Electric Co., Ltd.), 29 November 1983 (29.11.1983), page 2, line 7 to page 4, line 12; fig. 2, 4 (Family: none)	1, 7 2-6
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 010133/1975 (Laid-open No. 092037/1976) (Tokyo Shibaura Electric Co., Ltd.), 23 July 1976 (23.07.1976), entire text; all drawings (Family: none)	1-7

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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

"I" 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
15 January, 2013 (15.01.13)Date of mailing of the international search report
29 January, 2013 (29.01.13)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/007827

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 156664/1977 (Laid-open No. 083855/1979) (Hitachi, Ltd.), 14 June 1979 (14.06.1979), entire text; all drawings (Family: none)	1-7
A	JP 63-021725 A (Matsushita Electric Industrial Co., Ltd.), 29 January 1988 (29.01.1988), entire text; all drawings (Family: none)	1-7
A	WO 2010/097882 A1 (Panasonic Corp.), 02 September 2010 (02.09.2010), entire text; all drawings & EP 2402974 A1 & CN 102334174 A	1-7
A	JP 59-081834 A (Hitachi, Ltd.), 11 May 1984 (11.05.1984), entire text; all drawings (Family: none)	1-7

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/007827

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
See extra sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/007827

Continuation of Box No.III of continuation of first sheet(2)

On account of the following reason, the present application involves four inventions which do not comply with unity of invention.

Document 1: Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 076530/1982 (Laid-open No. 178264/1983) (Tokyo Shibaura Electric Co., Ltd.), 29 November 1983 (29.11.1983), page 2, line 7 to page 4, line 12; fig. 2, 4 (Family: none)

Document 1 discloses "a magnetron comprising an anode cylinder having a high frequency output unit, a permanent magnet provided on both ends of the anode cylinder, and a magnetic yoke housing the anode cylinder and the permanent magnet therein, wherein a plurality of lugs are provided on a high frequency output side of the magnetic yoke, wherein a metal plate suitable for the high frequency output unit and the lugs are arranged between the permanent magnet and the magnetic yoke, and wherein the anode cylinder and the magnetic yoke are fixed in relative positions. Consequently, the invention of claim 1 is not novel over the invention disclosed in document 1, and thus does not have a special technical feature.

As a result of judging special technical features with respect to claims 1-7, it is considered that four inventions which are linked by respective special technical features indicated below are involved.

Meanwhile, the inventions of claims 1 and 7 having no special technical feature are classified into a main invention group.

First invention: claims 1-2 and 7

The inventions of claims 1 and 7, and the invention having a special technical feature which is relevant to the matter set forth in claim 2.

Second invention: claim 3

The invention having a special technical feature which is relevant to the matter set forth in claim 3.

Third invention: claim 4

The invention having a special technical feature which is relevant to the matter set forth in claim 4.

Fourth invention: claims 5-6

The invention having a special technical feature which is relevant to the matter set forth in claim 5.

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 S5981834 A [0005]
- JP 2011266565 A [0096]