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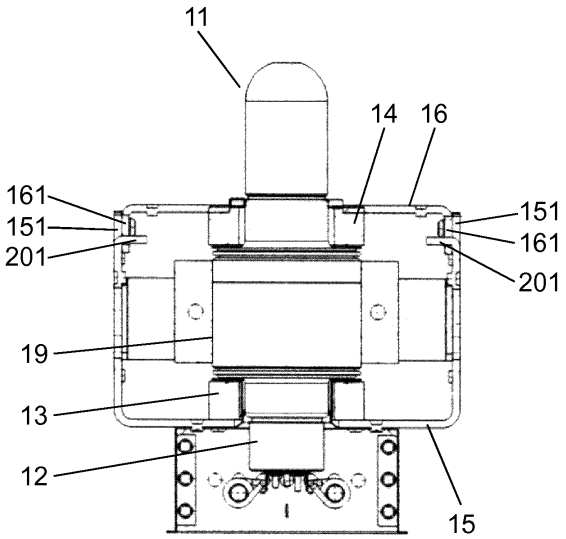
(54) MAGNETRON AND MICROWAVE HEATING DEVICE EQUIPPED WITH SAME

(57) A magnetron according to an aspect of the present disclosure comprises a magnetic circuit that includes permanent magnets and a yoke. The yoke includes a first yoke and a second yoke that are joined together. The first yoke and the second yoke of the magnetron according to this aspect are joined together by plastic deformation of a joint part provided integrally with at least one of the first yoke or the second yoke. This aspect can prevent the magnetron from being used in a manner that is not guaranteed by a manufacturer, such as using a non-genuine replacement for a component. Thus unstable operation can be suppressed, and a shortened life can be prevented. The magnetron that can be provided consequently cannot be disassembled unless the components are destroyed and thus is highly reliable.

FIG. 2



EP 3 651 179 A1

Description

TECHNICAL FIELD

[0001] The present disclosure relates to a magnetron that is difficult to disassemble and a microwave heating device including the magnetron.

BACKGROUND ART

[0002] A conventional magnetron that is a microwave generator is structurally broken down from a functional aspect into a magnetic circuit section, a cooling circuit section, an LC filter circuit section, and a core tube. The core tube includes a top shell part with an antenna part and also includes an anode part and a cathode part.

[0003] The magnetron is an electron tube that generates microwaves by converting direct current energy applied between the anode part and the cathode part to high-frequency energy by means of electron motion in an interaction space between the anode part and the cathode part where orthogonal static electromagnetic fields are created. The magnetron is widely used as the microwave generator for a microwave heating device such as a microwave oven because of its relatively high oscillation efficiency and ease of increased output (refer to, for example, PTL 1).

[0004] FIG. 6 is a perspective view of the conventional magnetron. FIG. 7 is a sectional view of the core tube of the conventional magnetron. FIG. 8 illustrates in section exterior components of the conventional magnetron, apart from the core tube.

[0005] In these drawings, core tube 19 of the typical magnetron is formed by a vacuum sealing. Coiled filament 1 is disposed in a center of the cathode part of the magnetron. Filament 1 is supported by center lead 4 and side lead 5. Center lead 4 is connected to side lead 5 via end hat 2 and end hat 3 that are provided respectively at both ends of filament 1.

[0006] The anode part of the magnetron includes anode cylinder 6 and an even number of vanes 7 projecting from an inner peripheral surface of anode cylinder 6 toward filament 1. Vanes 7 are provided to keep a predetermined distance from filament 1. Cavity resonators 8 are defined by vanes 7 and the inner peripheral wall surface of anode cylinder 6.

[0007] A pair of mortar-shaped magnetic pole parts 9 and 10 of substantially identical shape are disposed respectively at axial ends of anode cylinder 6 to face each other. Input unit 12 is provided outwardly of an axial end of magnetic pole part 9 and supplies to filament 1 heating power and a high voltage that drives the magnetron. Output unit 11 is provided outwardly of an axial end of magnetic pole part 10 and radiates microwaves generated in the anode part. Core tube 19 is covered with respective vacuum walls of output unit 11 and input unit 12.

[0008] A description is provided next of the exterior components other than core tube 19. A pair of annular permanent magnets 13 and 14 have their respective pole faces magnetically coupled to magnetic pole parts 9 and 10, respectively. Moreover, the pair of annular permanent magnets 13 and 14 have their respective opposite pole faces magnetically coupled to frame-shaped yokes 15 and 16, respectively. In this way, the magnetic circuit section is configured. Frame-shaped yokes 15 and 16 are made of a ferromagnetic material and are combined together to have a quadrangular profile.

[0009] Consequently, a direct current magnetic field is supplied to electron motion space 17 formed between filament 1 and vanes 7.

[0010] In the above magnetron, heating filament 1 and applying a predetermined high direct-current voltage between filament 1 and vanes 7 cause emission of electrons from filament 1 toward vanes 7.

[0011] The electrons are affected by the orthogonal electromagnetic fields in electron motion space 17 between filament 1 and vanes 7. The electrons head toward vanes 7 while circling filament 1. The electrons interact with weak 2,450 MHz-band microwaves generated in cavity resonators 8 divided by vanes 7, whereby large microwaves are generated in cavity resonators 8.

[0012] The microwaves thus generated in cavity resonators 8 are transmitted by antenna lead 18 electrically coupled to one of vanes 7 and are radiated into a heating chamber of the microwave oven through output unit 11.

Citation List

Patent Literature

[0013] PTL 1: U.S. Patent No. 8,264,150

SUMMARY

[0014] In the above-described conventional structure, the components other than core tube 19 can be used semipermanently. Disassembly of the magnetron and replacement of core tube 19 can be done by simple work such as removal of screws 21. Therefore, the magnetron may be used in a manner that is not guaranteed by a manufacturer, such as using a non-genuine replacement for the component. This causes unstable operation and leads to a shortened life.

[0015] An object of the present disclosure is to provide a highly reliable magnetron that cannot be disassembled unless the components are destroyed.

[0016] A magnetron according to one aspect of the present disclosure comprises a magnetic circuit that includes permanent magnets and a yoke. The yoke includes a first yoke and a second yoke that are joined together. The first yoke and the second yoke of the magnetron according to this aspect are joined together by plastic deformation of a joint part provided integrally with at least one of the first yoke or the second yoke.

[0017] This aspect can prevent the magnetron from being used in a manner that is not guaranteed by a man-

ufacturer, such as using a non-genuine replacement for a component. Thus unstable operation can be suppressed, and a shortened life can be prevented. The magnetron that can be provided consequently cannot be disassembled unless the components are destroyed and thus is highly reliable.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

FIG. 1 is a perspective view of a magnetron according to a first exemplary embodiment of the present disclosure.

FIG. 2 illustrates in section exterior components of the magnetron according to the first exemplary embodiment, apart from a core tube.

FIG. 3 is an enlarged view of a portion of the magnetron according to the first exemplary embodiment before a claw of an input-side frame-shaped yoke is bent.

FIG. 4A is an enlarged view of a portion of the magnetron according to the first exemplary embodiment, as seen from outside, with the claw of the input-side frame-shaped yoke bent.

FIG. 4B is an enlarged view of a portion of the magnetron according to the first exemplary embodiment, as seen from inside, with the claw of the input-side frame-shaped yoke bent.

FIG. 5 is an enlarged view illustrating a portion of a yoke of a magnetron according to a second exemplary embodiment of the present disclosure.

FIG. 6 is a perspective view of a conventional magnetron.

FIG. 7 is a sectional view of a core tube of the conventional magnetron.

FIG. 8 illustrates in section exterior components of the conventional magnetron, apart from the core tube.

DESCRIPTION OF EMBODIMENTS

[0019] A magnetron according to a first aspect of the present disclosure comprises a magnetic circuit that includes permanent magnets and a yoke. The yoke includes a first yoke and a second yoke that are joined together. The first yoke and the second yoke of the magnetron according to this aspect are joined together by plastic deformation of a joint part provided integrally with at least one of the first yoke or the second yoke.

[0020] While being based on the first aspect, a magnetron according to a second aspect of the present disclosure is such that the first yoke and the second yoke are joined together by swaging.

[0021] While being based on the first aspect, a magnetron according to a third aspect of the present disclosure is such that the first yoke includes a claw serving as the joint part. The second yoke includes a hole. The claw is bent by swaging to engage the hole.

[0022] While being based on the first aspect, a magnetron according to a fourth aspect of the present disclosure is such that the first yoke includes a claw serving as the joint part. The claw includes an engagement projection. The second yoke includes a hole and an engagement part provided in the hole. The claw is bent by swaging, and the engagement projection engages with the engagement part.

[0023] A microwave heating device according to a fifth aspect of the present disclosure includes the magnetron according to the first aspect.

[0024] With reference to the drawings, a description is hereinafter provided of exemplary embodiments of the present disclosure.

FIRST EXEMPLARY EMBODIMENT

[0025] FIG. 1 is a perspective view of a magnetron according to the first exemplary embodiment of the present disclosure. FIG. 2 illustrates in section exterior components of the magnetron according to the present exemplary embodiment, apart from a core tube. FIG. 3 is an enlarged view of a portion of the magnetron according to the present exemplary embodiment before a claw of an input-side frame-shaped yoke is bent.

[0026] FIG. 4A is an enlarged view of a portion of the magnetron according to the present exemplary embodiment, as seen from outside, with the claw of the input-side frame-shaped yoke bent. FIG. 4B is an enlarged view of a portion of the magnetron according to the present exemplary embodiment, as seen from inside, with the claw of the input-side frame-shaped yoke bent.

[0027] As illustrated in FIGS. 1 and 2, frame-shaped yoke 15 is disposed to have a U-shaped profile. Frame-shaped yoke 16 is disposed to have an inverted U-shaped profile.

[0028] Disposed frame-shaped yokes 15 and 16 overlap at their respective ends. When frame-shaped yokes 15 and 16 are joined together in this condition, a tubular frame-shaped yoke having a quadrangular section is formed. In the present exemplary embodiment, frame-shaped yokes 15 and 16 correspond to the first yoke and the second yoke, respectively.

[0029] As illustrated in FIG. 3, the two ends of frame-shaped yoke 15 are each formed with, substantially at their midpoint, notch 151. Claw 201 is formed integrally with frame-shaped yoke 15 to protrude in each of notches 151. Claw 201 is formed with, at its leading end, hook-shaped engagement projection 202. In the present exemplary embodiment, claw 201 corresponds to the joint part.

[0030] As illustrated in FIGS. 1 and 3, the two ends of frame-shaped yoke 16 are each formed with, substantially at their respective midpoint, hole 161. Each of provided holes 161 faces claw 201 of frame-shaped yoke 15 as illustrated in FIGS. 4A and 4B. Engagement part 162 is formed in hole 161, so that hole 161 is substantially

L-shaped.

[0031] When the magnetron is assembled, annular permanent magnet 13 is placed on a central part of an inner side of frame-shaped yoke 15 to surround a hole formed in frame-shaped yoke 15. An input side of assembled core tube 19 is inserted into annular permanent magnet 13 and frame-shaped yoke 15. An output side of core tube 19 is inserted into annular permanent magnet 14 and frame-shaped yoke 16. Frame-shaped yokes 15 and 16 are riveted together at their overlapping parts, thus forming the tubular frame-shaped yoke having the quadrangular profile.

[0032] Claw 201 is bent about 90° toward hole 161 by swaging to be engaged to a peripheral edge defined by hole 161. When claw 201 of frame-shaped yoke 15 engages hole 161 of frame-shaped yoke 16 to thus fasten frame-shaped yokes 15 and 16 together, the magnetron cannot be disassembled.

[0033] In the present exemplary embodiment, the bending angle of claw 201 is about 90°. If the bending angle is greater than or equal to 90°, secure engagement is effected between frame-shaped yokes 15 and 16.

[0034] As described above, claw 201 (the joint part) provided integrally with at least one of frame-shaped yoke 15 or frame-shaped yoke 16 undergoes plastic deformation (the swaging) to join frame-shaped yokes 15 and 16 together in the present exemplary embodiment.

[0035] In the present exemplary embodiment, hook-shaped engagement projection 202 is formed at the leading end of claw 201. Engagement projection 202 is, so to speak, L-shaped. However, claw 201 may be T-shaped. In that case, two engagement parts 162 have only to be formed in hole 161.

[0036] In the present exemplary embodiment, frame-shaped yokes 15 and 16 are riveted together at their overlapping parts, thus being fastened together. However, this is not limiting. Frame-shaped yokes 15 and 16 may be fastened together, for example, with tapping screws.

[0037] The present exemplary embodiment described above can prevent the magnetron from being used in a manner that is not guaranteed by a manufacturer, such as using a non-genuine replacement for the component. Thus unstable operation can be suppressed, and a shortened life can be prevented. The magnetron that can be provided consequently cannot be disassembled unless the components are destroyed and thus is highly reliable.

SECOND EXEMPLARY EMBODIMENT

[0038] A description is hereinafter provided of the second exemplary embodiment of the present disclosure. In the following description, parts identical or corresponding to those in the first exemplary embodiment have the same reference marks, and there are no repeated descriptions of these parts.

[0039] FIG. 5 is an enlarged view illustrating a portion of a yoke of a magnetron according to the present exemplary embodiment. The present exemplary embodiment is similar to the first exemplary embodiment in that claw 203 is bent to engage hole 163. However, the present exemplary embodiment has the following differences from the first exemplary embodiment.

[0040] As illustrated in FIG. 5, claw 203 is not provided with engagement projection 202, and engagement part 162 is not provided in hole 163 in the present exemplary embodiment. In the present exemplary embodiment, claw 203 is preferably bent 90° or more to be anchored.

[0041] The present exemplary embodiment described above can prevent the magnetron from being used in a manner that is not guaranteed by a manufacturer, such as using a non-genuine replacement for the component. Thus unstable operation can be suppressed, and a shortened life can be prevented. The magnetron that can be provided consequently cannot be disassembled unless the components are destroyed and thus is highly reliable.

INDUSTRIAL APPLICABILITY

[0042] The present disclosure is applicable to magnetrons.

REFERENCE MARKS IN THE DRAWINGS

[0043]

1:	filament
2, 3:	end hat
4:	center lead
5:	side lead
6:	anode cylinder
7:	vane
8:	cavity resonator
9, 10:	magnetic pole part
11:	output unit
12:	input unit
13, 14:	annular permanent magnet
15, 16:	frame-shaped yoke
17:	electron motion space
18:	antenna lead
19:	core tube
21:	screw
151:	notch
161, 163:	hole
162:	engagement part
201, 203:	claw
202:	engagement projection

Claims

1. A magnetron comprising a magnetic circuit, the magnetic circuit including permanent magnets and a yoke, the yoke including a first yoke and a second yoke that are joined together,
wherein the first yoke and the second yoke are joined together by plastic deformation of a joint part provid-

ed integrally with at least one of the first yoke or the second yoke.

2. The magnetron according to claim 1, wherein the first yoke and the second yoke are joined together by swaging.

3. The magnetron according to claim 1, wherein:

the first yoke includes a claw serving as the joint part;
the second yoke includes a hole; and
the claw is bent by swaging and engages the hole.

4. The magnetron according to claim 1, wherein:

the first yoke includes a claw serving as the joint part;
the claw includes an engagement projection;
the second yoke includes a hole and an engagement part provided in the hole; and
the claw is bent by swaging with the engagement projection engaging with the engagement part.

5. A microwave heating device comprising the magnetron according to claim 1.

FIG. 1

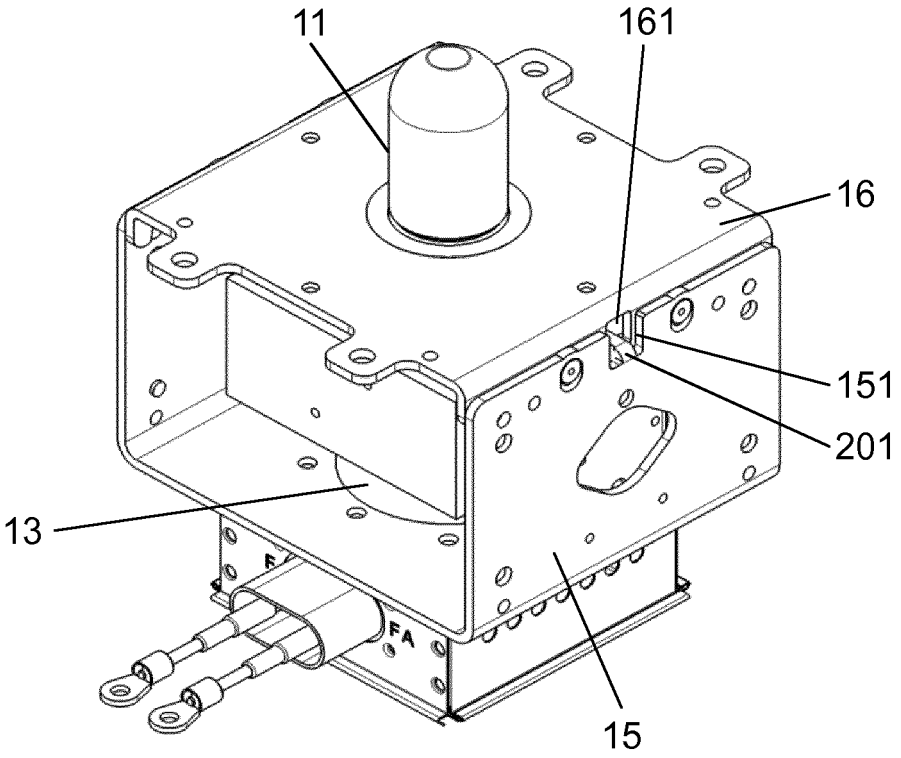


FIG. 2

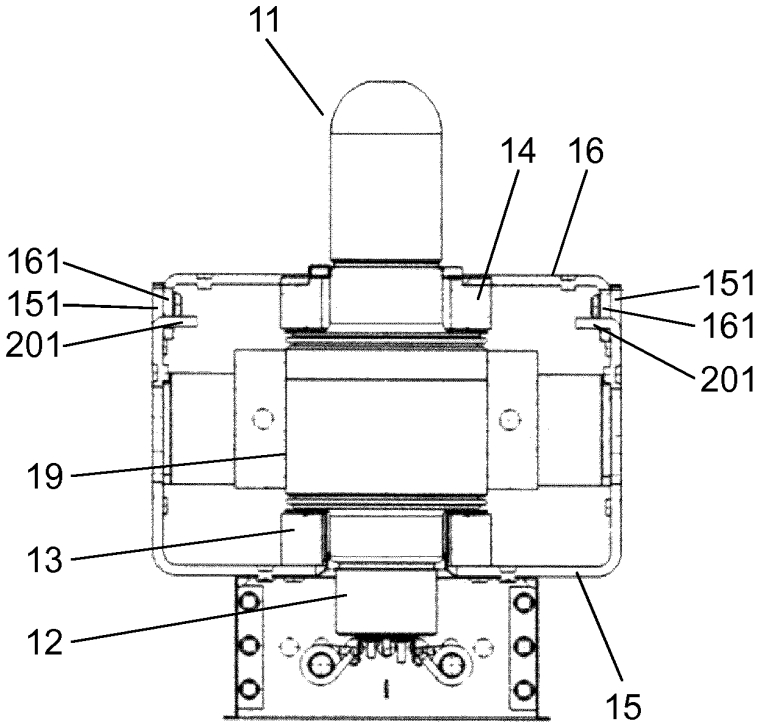

11
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FIG. 3

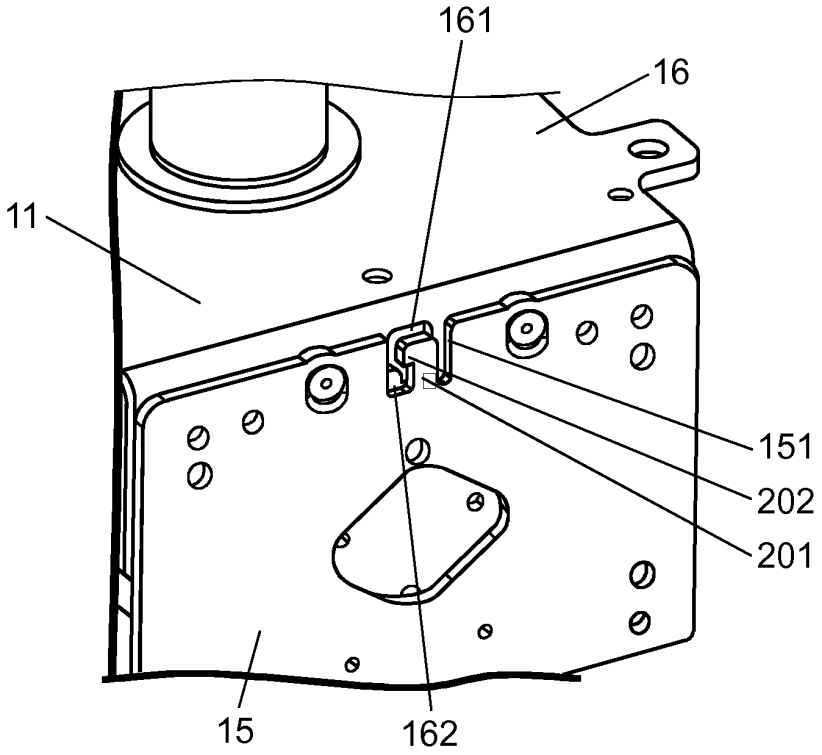

161
16
11
151
202
201
15
162

FIG. 4A

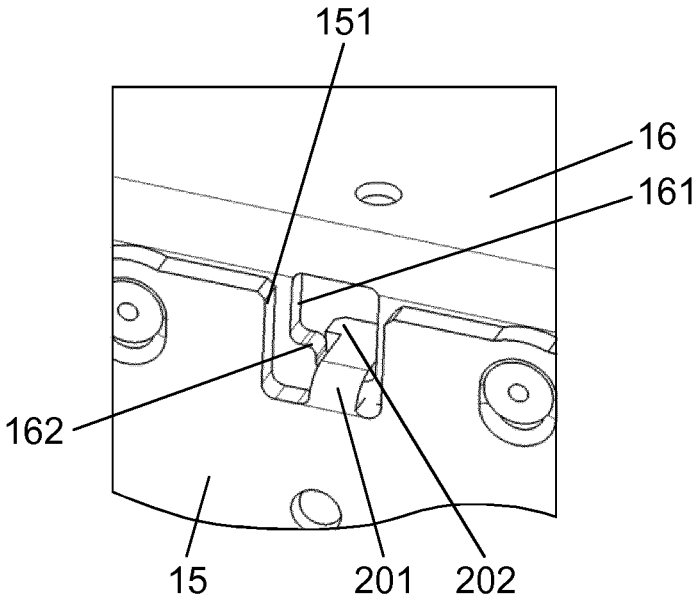


FIG. 4B

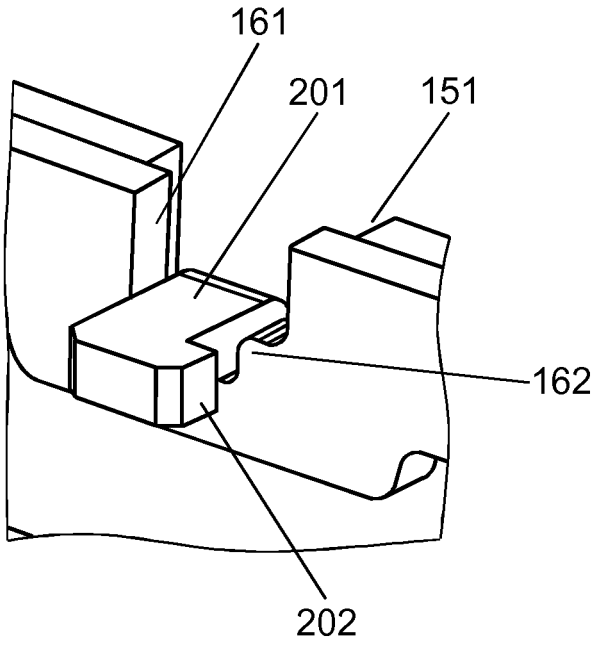


FIG. 5

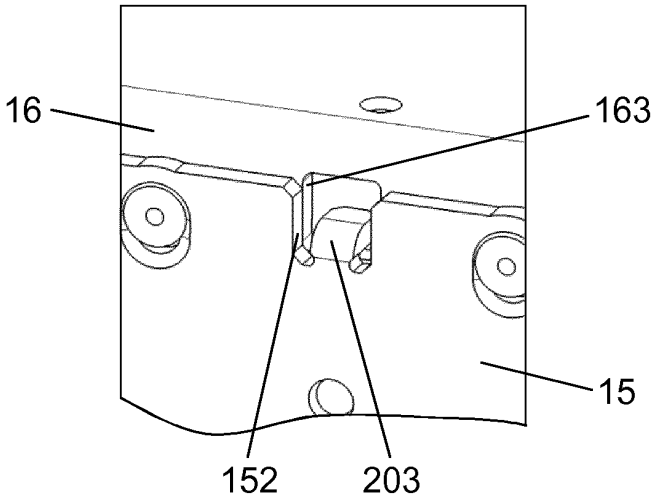


FIG. 6

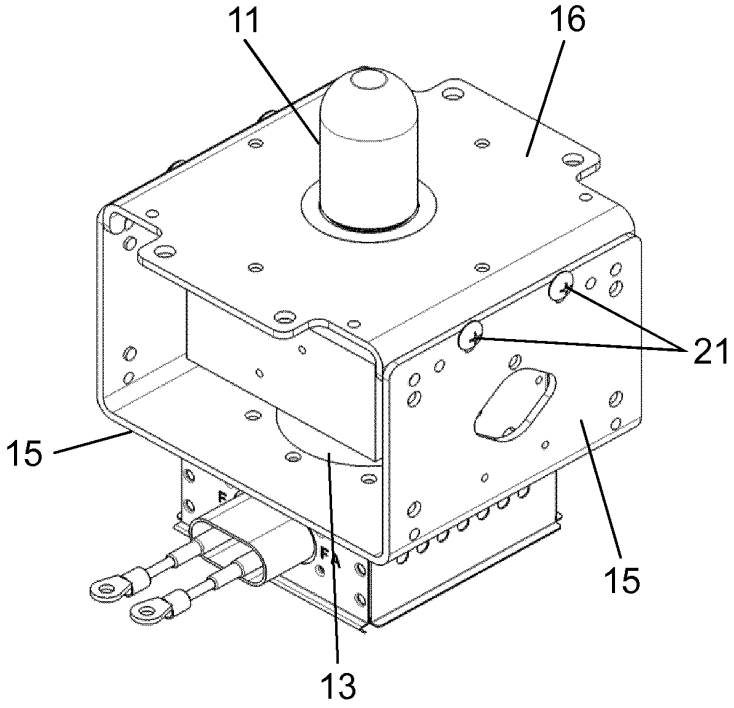


FIG. 7

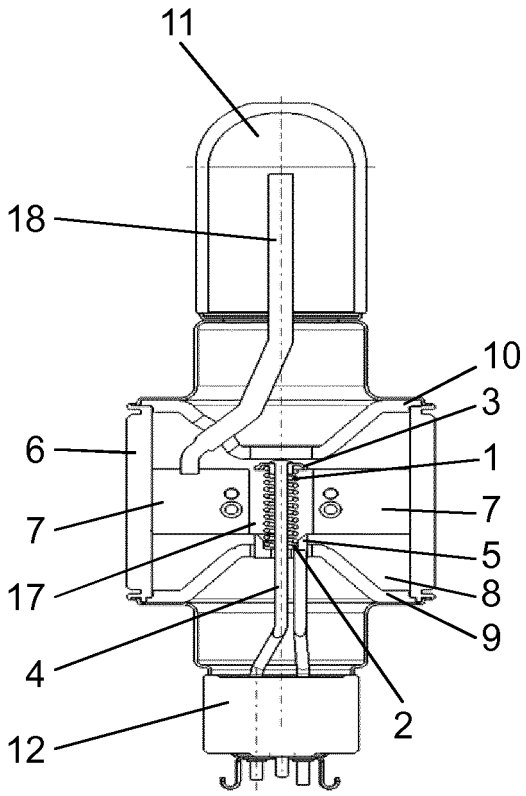
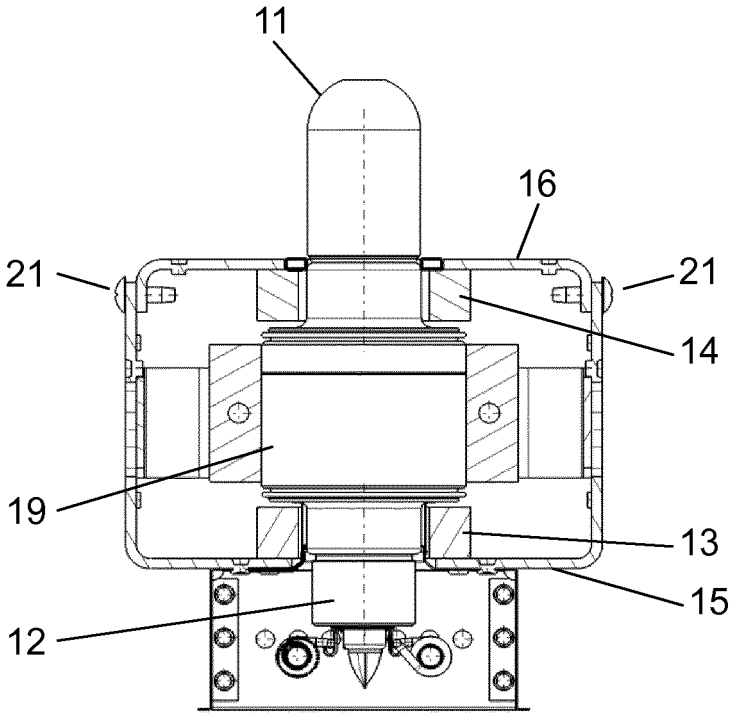


FIG. 8



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/024536

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. 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)
Int.Cl. H01J23/12

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

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 Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 202443/1986 (Laid-open No. 176947/1987) (SANYO ELECTRIC CO., LTD.) 10 November 1987, specification, page 4, line 6 to page 7, line 3, fig. 4, 5 (Family: none)	1-3, 5 4
Y	JP 3-238735 A (MATSUSHITA ELECTRON CORP.) 24 October 1991, specification, page 1, right column, line 11 to page 2, upper left column, line 4, fig. 4 (Family: none)	4

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"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 06.09.2018	Date of mailing of the international search report 18.09.2018
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 8264150 B **[0013]**