

Description

FIELD OF THE INVENTION AND RELATED ART STATEMENT

1.FIELD OF THE INVENTION

The present invention relates to a magnetron device used in a microwave heating apparatus such as microwave oven.

2.RELATED ART STATEMENT

In general, a magnetron device to be used in a microwave heating apparatus which has been on the market and partly disclosed in the United States Patent No. 5,021,713 has a configuration such as shown in Fig.10. It works at a fundamental frequency of 2,450 MHz. A magnetron 1 has an anode cylinder 3, a coil-shaped cathode 2 disposed coaxially with and in the anode cylinder, a pair of frust-conical magnetic pole pieces 4 and 5 disposed above and under the cathode 2, respectively, a microwave radiation antenna 6 at the top and a stem insulator 7. A frame-shaped magnetic yoke 8 is for constituting an external magnetic circuit together with a permanent magnet which is located outside the figure. The stem insulator 7 is contained in a shielding metal case 9 which is attached to a bottom plate part of the magnetic yoke 8. A pair of cathode terminals 10 are disposed on the lower end-face of the stem insulator 7 (in a manner that they are disposed symmetrically with regard to the plane of sheet of FIG.10); and respective one-ends of a pair of core-insertion-type choke coils 11 are connected to the pair of cathode terminals. Respective other-ends of a pair of core-insertion-type choke coils 11 are connected to a pair of feed-through electrodes 13 of a feed-through-type capacitor 12 attached to the side wall of the shielding metal case 9, respectively. The core-insertion-type choke coil 11 has an inductance-increasing ferrite core 14, which also converts a part of electromagnetic energy induced by a microwave current in the core-insertion-type choke coil 11 thereby to attenuate undesirable radiation of the microwave energy to outside space of the microwave oven.

In the conventional magnetron device constituted in a manner as stated above, undesirable external leakage to the outside of the apparatus the microwave radiation to the cathode terminal 10 from a resonant cavity of the magnetron 1 is stopped by an LC filter circuit comprising the core-insertion-type choke coil 11 and the feed-through-type capacitor 12 and the shielding metal case 9. And, since the ferrite core 14 has not only the function as an inductor but also the function of radio frequency power absorption, external leakage of 30 - 300 MHz frequency range components to the outside of the apparatus of unnecessary radiation can be stopped efficiently.

In a magnetron device described in USP 4,131,824, as is shown in Fig.11, such a configuration is taken that an air-core-type choke coil 11' is inserted between the cathode terminal 10 and the core-insertion-type choke coil 11. In this case, the unnecessary radiation including the fundamental wave component appearing on the cathode terminal side reaches to the core-insertion-type choke coil 11 after attenuation by this air-core-type choke coil 11', and therefore possible burn-out of the ferrite core 14 and choke coil 11' can be prevented.

However, in order to prevent the generation of noise in 30 - 300 MHz range through suppressing of undesirable leakage of the unnecessary radiation to the outside of the apparatus, and also to prevent thoroughly the burn-out of the ferrite core 14 and the choke coil 11, it is necessary to increase the pitch of winding of the air-core-type choke coil 11' keeping the turn number of the core-insertion-type choke coil 11. Therefore, a series-connected body of the choke coils 11 and 11' becomes large and long, hence in order to store it inside the shielding metal case 9, it is necessary to keep the internal volume of the shielding metal case 9 sufficiently large. Then there has been a problem that the requirement of keeping the size of the shielding metal case 9 small was hindered. Also there has been another problem that a stable holding of the above-mentioned large and long series-connected body inside the shielding metal case 9 became difficult.

EP-A-339374 discloses a magnetron with cathode terminals, which are disposed projecting from an external end face of a stem insulator, and conductive films are formed on the internal end face of the stem insulator connected to the cathode terminals, said conductive films having an electrical length, which is a sub-multiple of the wave length of the harmonics the leakage of which is to be prevented, and which conductive films may be combined with a LC filter circuit of a well known type.

OBJECT AND SUMMARY OF THE INVENTION

The magnetron device in accordance with the present invention is defined by the features of claims 1 or 3.

By constituting one of these magnetron devices, a part of the unnecessary radiation including the fundamental wave component appearing on the cathode terminal side from the resonant cavity of the magnetron is decreased owing to the reflecting action of the antenna-like electrodes. As a result, burn-out due to excessive dissipation in the core-insertion-type choke coil can be prevented. Since the cathode electrodes are connected to a series-connected point between the core-insertion-type choke coil and the antenna-like electrode, a stable holding thereof becomes possible. Furthermore, since the space in the

shielding metal case can be utilized efficiently by dispensing with space-taking air-core-type choke coil, reduction of size of the shielding metal case as well as reduction of the production-cost become passable. Also, since the air-core-type choke coil is not connected in series to the core-insertion-type choke coil, at the time of using an inverter power supply, in particular, drop of the cathode voltage can be prevented. Still furthermore, it is found that noise in the lower side band (LSB) and the upper side band (USB) are drastically decreased, thereby eliminating undesirable noise radiation to outside space and especially for portable telephone signal, thus rendering the magnetron oscillation very clean.

As has been explained above, in accordance with the present invention, not only the burn-out of the core-insertion-type choke coil can be prevented, but also the stable holding of the core-insertion-type choke coil becomes possible, and moreover, size reduction of the shielding metal case as well as reduction of the production-cost become passable. Also, at the time of using an inverter power supply, drop of the cathode voltage can be prevented. Furthermore, as a result of experiments, it became clear that the noise at both side-bands having its center at the fundamental wave band thereof as well as the noise at the side-bands of the harmonics could be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1 is a partly sectional side view of a magnetron device using the present invention.

FIG.2 is a bottom view of principal part of the same magnetron device.

FIG.3 is a perspective view of the principal part of another embodiment of the present invention.

FIG.4 is a cold attenuation characteristic curve of the magnetron device whereon the present invention is applied.

FIG.5 is a graph of surface temperature characteristic curves of a core-insertion-type choke coil of the same magnetron device.

FIG.6 is a side view of the principal part of another embodiment of the present invention.

FIG.7 is a bottom view of principal part of the same embodiment.

FIG.8 shows comparison graphs for cold loss of (a) prior art and (b) the present invention measured by connecting a measuring device from the connecting point of ends 11a of core-insertion-type choke coil 11 and feed-through-type electrodes 13 of feed-through type capacitors 12 to a microwave radiation antenna 6.

FIG.9 shows comparison graphs for noise levels at oscillation of (a) the prior art and (b) the present invention.

FIG.10 is a partly sectional side view of a magnetron device of prior art.

Fig.11 is a side view of a part of a magnetron device of the prior art.

It will be recognized that some or all of the Figures are schematic representations for purposes of illustration and do not necessarily depict the actual relative sizes or locations of the elements shown.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Next, the present invention is explained with reference to the embodiments shown by drawings FIGs. 1 through FIG.7.

As shown in FIGs. 1 and 2, a magnetron 1 has an anode cylinder 3, a coil-shaped cathode 2 disposed coaxially with and in the anode cylinder, a pair of frust-conical magnetic pole pieces 4 and 5 disposed above and under the cathode 2, respectively, a microwave radiation antenna 6 at the top and a stem insulator 7. A frame-shaped magnetic yoke 8 is for constituting an external magnetic circuit together with a permanent magnet which is located outside the figure. The stem insulator 7 is contained in a shielding metal case 9 which is attached to a bottom plate part of the magnetic yoke 8. A pair of cathode terminals 10 are disposed on the lower end-face of the stem insulator 7 in a manner that they are disposed symmetrically with the plane of sheet of FIG.1; and respective one-ends of a pair of core-insertion-type choke coils 11 are connected to the pair of cathode terminals. Respective other-ends of the pair of core-insertion-type choke coils 11 are connected directly (without intermedating any device) to a pair of feed-through electrodes 13 of a feed-through-type capacitor 12 attached to the side wall of the shielding metal case 9, respectively. A pair of antenna-like electrodes 15, 15 are provided attached to the respective cathode terminals 10, 10 in a manner or configuration that, for example, they linearly extends from the respective connecting leads 110, 110 between the core-insertion-type choke coils 11, 11 and the cathode terminals 10, 10, or that they extends from the respective connecting leads 110, 110 but folded at the part of the cathode terminals 10, 10. The other end of each antenna-like electrodes 15, 15 does not have any terminating connection. Each core-insertion-type choke coil 11 has an inductance-increasing ferrite core 14, which also converts a part of electromagnetic energy induced by a microwave current in the core-insertion-type choke coil 11 thereby to attenuate undesirable radiation of the microwave energy to outside space of the microwave oven.

In summary, a first featuring point or difference of the configuration of the embodiment shown in Fig.1 and Fig.2 from that of the conventional example shown in Fig.8 is that: respective other-ends 11a of two core-insertion-type choke coils 11, whose respective one-ends connected respectively to a pair of cathode terminals 10 of a magnetron 1, are connect-

ed absolutely directly to respective pair of feed-through-type electrodes 13 of feed-through-type capacitors 12. That is no air-core-type choke coils 11' like in FIG.10 do not intermediate inbetween. A second featuring point is that antenna-like electrodes 15 are extending from the respective cathode terminals 10 without having any terminating connection.

Apart from the above-mentioned example where antenna-like electrodes 16 are parts linearly extended parts of the core-insertion-type choke coils 11, a further embodiment can be configured such as shown in Fig.3 where a separate bar-shaped conducting wire is used as the antenna-like electrode 16, and it is caulked to the cathode terminal 10. In FIG.3, L designates the length of extension of the antenna-like electrode 16.

As is shown in Fig.4, it was found that, when the extension length L (shown in FIGs. 1 and 3) is 15 mm or more, amount of the cold attenuation (i.e. attenuation at cold condition) reached to as large as 55 dB. Hereupon, this value can correspond to an amount of the cold attenuation in the conventional configuration of FIG.11, wherein the air-core-type choke coil was used. Also, the surface temperature at one-end (connecting-end to the cathode terminal side) and the surface temperature at the other-end (connecting-end to the capacitor side) respectively of the core-insertion-type choke coil 11 could be kept so low as at 100°C, as is shown respectively by curves a and b in Fig.5.

Apart from the above-mentioned embodiment, the antenna-like electrode can take either shapes of bent or coiled. In those embodiments shown in Fig.6 and Fig.7, the configuration feature is such that two semi-circular arc shaped conductive films 17 are disposed on the bottom surface of the ceramic stem insulator 7 as antenna-like electrodes; and their respective one-ends are connected electrically to the cathode terminals 10. In this case, it is possible to obtain the same amount of the cold attenuation as in the embodiment described previously, and besides that, the shielding metal case can be formed in a still smaller size.

FIG.8 and FIG.9 comparingly show cold losses and noise levels at oscillation, respectively, for the prior art (shown by respective graphs (a)) and the present invention (shown by respective graphs (b)). The cold losses of the prior art and the present invention are measured by a known measuring device which is connected from the connecting point of ends 11a of core-insertion-type choke coil 11 and feed-through-type electrodes 13 of feed-through type capacitors 12 to a microwave radiation antenna 6.

As shown by FIG.8, the cold loss (which is the loss at non oscillation state of the magnetron) is much improved from the prior art of graph (a) to the present invention of graph (b). In other words undesirable radiation of microwave is much decreased in the present invention.

Thus, as shown by FIG.9, the noise level at oscillation is much decreased in general, and in particular concerning the lower side band and the upper side band, which are overlapping with the frequency bands of a portable telephones (movable telephones). Therefore, the magnetron of the present invention is very much clean in radiation of noise in the outside space.

Claims

1. A magnetron device comprising:
 - a magnetron in which cathode terminals (10) are disposed such that they project from an external end face of a stem insulator (7),
 - a filter (11) connected to the cathode terminals (10), and
 - antenna-like electrodes (15), which are attached to the respective cathode terminals (10), while the other end of said antenna-like electrodes (15) is free of any terminating connection, characterized in that
 - said filter comprises core-insertion-type choke coils (11), which are series-connected to each of said cathode terminals (10), and
 - each of said antenna-like electrodes (15) is formed as extended part of one end of said core-insertion-type choke coils (11).
2. A magnetron device in accordance with claim 1, wherein
 - each said antenna-like electrode (15) is configured as folding one end of said core-insertion-type choke coils (11).
3. A magnetron device comprising:
 - a magnetron in which cathode terminals (10) are disposed such that they project from an external end face of a stem insulator (7),
 - a filter (11) by being series-connected to each of the cathode terminals (10), and
 - antenna-like electrodes (16), which are attached to the respective cathode terminals (10), while the other end of said antenna-like electrodes (16) is free of any terminating connection, characterized in that
 - said filter comprise core-insertion-type choke coils (11), which are series-connected to each of said cathode terminals (10), and
 - each of said antenna-like electrodes (16) is formed by caulking a separate bar-shaped conducting wire to said cathode terminal (10).

Patentansprüche

1. Eine Magnetroneneinrichtung, die aufweist:



ed absolutely directly to respective pair of feed-through-type electrodes 13 of feed-through-type capacitors 12. That is no air-core-type choke coils 11' like in FIG.10 do not intermediate inbetween. A second featuring point is that antenna-like electrodes 15 are extending from the respective cathode terminals 10 without having any terminating connection.

Apart from the above-mentioned example where antenna-like electrodes 16 are parts linearly extended parts of the core-insertion-type choke coils 11, a further embodiment can be configured such as shown in Fig.3 where a separate bar-shaped conducting wire is used as the antenna-like electrode 16, and it is caulked to the cathode terminal 10. In FIG.3, L designates the length of extension of the antenna-like electrode 16.

As is shown in Fig.4, it was found that, when the extension length L (shown in FIGs. 1 and 3) is 15 mm or more, amount of the cold attenuation (i.e. attenuation at cold condition) reached to as large as 55 dB. Hereupon, this value can correspond to an amount of the cold attenuation in the conventional configuration of FIG.11, wherein the air-core-type choke coil was used. Also, the surface temperature at one-end (connecting-end to the cathode terminal side) and the surface temperature at the other-end (connecting-end to the capacitor side) respectively of the core-insertion-type choke coil 11 could be kept so low as at 100°C, as is shown respectively by curves a and b in Fig.5.

Apart from the above-mentioned embodiment, the antenna-like electrode can take either shapes of bent or coiled. In those embodiments shown in Fig.6 and Fig.7, the configuration feature is such that two semi-circular arc shaped conductive films 17 are disposed on the bottom surface of the ceramic stem insulator 7 as antenna-like electrodes; and their respective one-ends are connected electrically to the cathode terminals 10. In this case, it is possible to obtain the same amount of the cold attenuation as in the embodiment described previously, and besides that, the shielding metal case can be formed in a still smaller size.

FIG.8 and FIG.9 comparably show cold losses and noise levels at oscillation, respectively, for the prior art (shown by respective graphs (a)) and the present invention (shown by respective graphs (b)). The cold losses of the prior art and the present invention are measured by a known measuring device which is connected from the connecting point of ends 11a of core-insertion-type choke coil 11 and feed-through-type electrodes 13 of feed-through type capacitors 12 to a microwave radiation antenna 6.

As shown by FIG.8, the cold loss (which is the loss at non oscillation state of the magnetron) is much improved from the prior art of graph (a) to the present invention of graph (b). In other words undesirable radiation of microwave is much decreased in the present invention.

Thus, as shown by FIG.9, the noise level at oscillation is much decreased in general, and in particular concerning the lower side band and the upper side band, which are overlapping with the frequency bands of a portable telephones (movable telephones). Therefore, the magnetron of the present invention is very much clean in radiation of noise in the outside space.

Claims

1. A magnetron device comprising:
 - a magnetron in which cathode terminals (10) are disposed such that they project from an external end face of a stem insulator (7),
 - a filter (11) connected to the cathode terminals (10), and
 - antenna-like electrodes (15), which are attached to the respective cathode terminals (10), while the other end of said antenna-like electrodes (15) is free of any terminating connection, characterized in that
 - said filter comprises core-insertion-type choke coils (11), which are series-connected to each of said cathode terminals (10), and
 - each of said antenna-like electrodes (15) is formed as extended part of one end of said core-insertion-type choke coils (11).
2. A magnetron device in accordance with claim 1, wherein
 - each said antenna-like electrode (15) is configured as folding one end of said core-insertion-type choke coils (11).
3. A magnetron device comprising:
 - a magnetron in which cathode terminals (10) are disposed such that they project from an external end face of a stem insulator (7),
 - a filter (11) by being series-connected to each of the cathode terminals (10), and
 - antenna-like electrodes (16), which are attached to the respective cathode terminals (10), while the other end of said antenna-like electrodes (16) is free of any terminating connection, characterized in that
 - said filter comprise core-insertion-type choke coils (11), which are series-connected to each of said cathode terminals (10), and
 - each of said antenna-like electrodes (16) is formed by caulking a separate bar-shaped conducting wire to said cathode terminal (10).

Patentansprüche

1. Eine Magnetroneneinrichtung, die aufweist:



ein Magnetron, in dem Kathodenanschlüsse (10) derartig angeordnet sind, daß sie von einer externen Endfläche eines Stabisolators (7) vorstehen,

ein Filter (11), das an die Kathodenanschlüsse (10) angeschlossen ist, und

antennenartige Elektroden (15), die an den jeweiligen Kathodenanschlüssen (10) angebracht sind, während das andere Ende der antennenartigen Elektroden (15) frei ist von irgendeiner Anschlußverbindung,

dadurch gekennzeichnet, daß

das Filter Drosselspulen (11) vom kernhaltigen Typ aufweist, die in Reihe geschaltet sind mit den jeweiligen Kathodenanschlüssen (10) und

jede der antennenartigen Elektroden (15) als ein verlängerter Teil eines Endes der Drosselspulen (11) vom kernhaltigen Typ ausgebildet ist.

2. Eine Magnetroneinrichtung nach Anspruch 1, wobei

jede der antennenartigen Elektroden (15) als ein gefaltetes Ende der Drosselspulen (11) vom kernhaltigen Typ ausgebildet ist.

3. Eine Magnetroneinrichtung, die aufweist:

ein Magnetron, in dem Kathodenanschlüsse (10) derartig angeordnet sind, daß sie von einer externen Endfläche eines Stabisolators (7) vorstehen,

ein Filter (11), das mit den jeweiligen Kathodenanschlüssen (10) in Reihe geschaltet ist, und

antennenartige Elektroden (16), die an die jeweiligen Kathodenanschlüsse (10) angefügt sind, während das andere Ende der antennenartigen Elektroden (16) frei ist von irgendeiner Anschlußverbindung,

dadurch gekennzeichnet, daß

das Filter Drosselspulen (11) vom kernhaltigen Typ aufweist, die mit jedem der Kathodenanschlüsse (10) in Reihe geschaltet sind, und

jede der antennenartigen Elektroden (16) ausgebildet ist, indem ein separater balkenförmiger Leitungsdraht mit dem Kathodenanschluß (10) verstemmt bzw. an den Kathodenanschluß (10) angestemmt ist.

(10), et

des électrodes en forme d'antennes (15), qui sont fixées aux bornes de cathode respectives (10), tandis que l'autre extrémité desdites électrodes en forme d'antennes (15) est libre de toute liaison de terminaison, caractérisé en ce que

ledit filtre comprend des bobines d'arrêt du type à noyau plongeur 11, lesquelles sont reliées en série à chacune desdites bornes de cathode (10), et

chacune desdites électrodes en forme d'antennes (15) est formée en tant que partie étendue d'une extrémité desdites bobines d'arrêt du type à noyau plongeur (11).

2. Dispositif à magnétron selon la revendication 1, dans lequel

chacune desdites électrodes en forme d'antennes (15) est configurée par pliage d'une extrémité desdites bobines d'arrêt du type à noyau plongeur (11).

3. Dispositif à magnétron comprenant :

un magnétron dans lequel les bornes de cathode (10) sont disposées de façon telle qu'elles se projettent à partir d'une face d'extrémité externe d'un isolateur de tige (7),

un filtre (11) étant connecté en série à chacune des bornes de cathode (10), et

des électrodes en forme d'antennes (16), lesquelles sont fixées aux bornes de cathode respectives (10), tandis que l'autre extrémité desdites électrodes en forme d'antennes (16) est libre de toute liaison de terminaison, caractérisé en ce que

ledit filtre comprend des bobines d'arrêt du type à noyau plongeur 11, lesquelles sont reliées en série avec chacune desdites bornes de cathode (10), et

chacune desdites électrodes en forme d'antennes (16) est formée en rivetant un câble conducteur en forme de tige séparé à ladite borne de cathode (10).

Revendications

1. Dispositif à magnétron comprenant :

un magnétron dans lequel des bornes de cathode (10) sont disposées de manière telle qu'elles se projettent à partir d'une face d'extrémité externe d'un isolateur de tige (7),

un filtre (11) relié aux bornes de cathode