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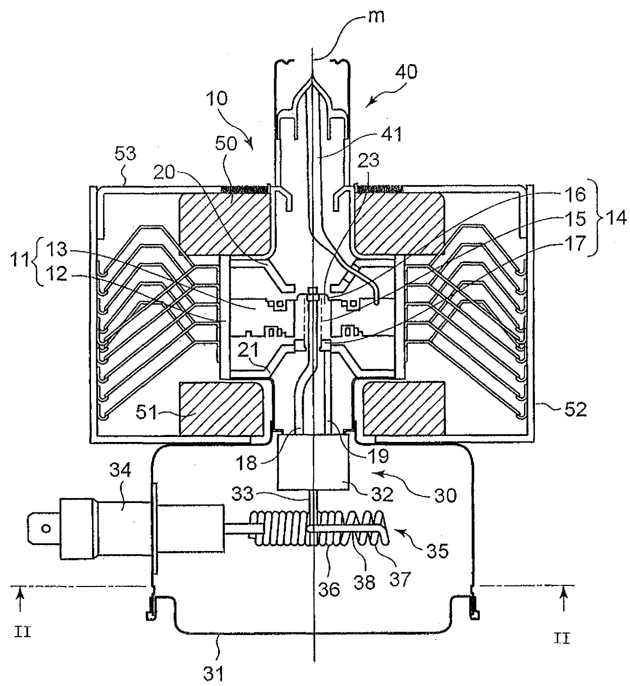
(54) **Magnetron device**

(57) A magnetron device in which the wire's diameter of coils for the core type inductor and the air-core type inductor is 1.0 to 1.4 mm, and the cross sectional area of the magnetic core is 5 to 16 mm^2, the number of turns of the coil for the air-core type inductor being

$$55<2\pi((D+A)/2)T\leq 90,$$

for the choke coil (35) accommodated in the filter box (31) disposed so as to cover the cathode terminal (33) of the magnetron tube body (10), which is comprised of the core type inductor (36) having the magnetic core (36a) and the air-core type inductor (37), and both thereof being serially connected together, where A (mm) is the wire's diameter of the coil, and D (mm) is the diameter of the magnetic core.

FIG. 1



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Description

Technical Field

[0001] The present invention relates to a magnetron device used for microwave ovens, etc., and especially to a choke coil mounted inside a filter box.

Background Art

[0002] The magnetron is provided with an oscillating portion comprising an anode portion, an input portion and an output portion. The anode portion comprises an anode cylinder and a plurality of vanes that are radially arranged inside the anode cylinder, a cathode portion of a filament positioned on the anode axis i.e. the tube axis, and a pair of pole pieces disposed on both ends of the anode cylinder. The input portion comprises a stem that supports a cathode lead extending upon penetrating one of the pole pieces of the oscillating portion, and the output portion includes an antenna extending upon penetrating the other of the pole pieces of the oscillating portion. The pole pieces are interposed between the permanent magnets, and converge the magnetic flux on the interaction space between the anode portion and the cathode portion.

[0003] The magnetron performs microwave oscillation upon supplying a filament current to the cathode through the input portion and applying a voltage between the anode portion and the cathode portion, and then outputs a microwave from the output portion. It is 2450 MHz band for a microwave oven. Because a part of the oscillation output leaks through the input portion and interferes external devices, the input portion is shielded with the filter box so as to prevent electric waves from being leaked. The oscillation output oscillates not only the fundamental wave of 2450 MHz but also many waves over a wide band due to electron disturbance, so that the filter box also prevents these waves from being leaked.

[0004] The filter box has a pair of feed-through capacitors functioning as external input terminals that are connected to an external power source, and is provided with a pair of choke coils that connect serially a pair of cathode input terminals with each feed-through capacitor respectively in the box. Each choke coil is comprised of a coil-like core type inductor having a ferrite core and an air-core type inductor of air-core coil, which are serially connected together. The diameter of the winding wire of copper constituting the coils is 1.4 to 1.6 mm, and the inner diameters of both of the inductors are equal to each other. The cross sectional area of the ferrite core is 15 to 30 mm^2. Setting of these values is determined upon taking the following matter into account (Refer to Japanese Patent Laid-open No. 2002-343263).

[0005] The choke coil constituting the filter circuit consumes a microwave leaking from the cathode portion as a heat. Therefore, the choke coil may be burned out if the leakage output is increased. In addition, leakage of microwave is raised because the inductance diminishes when the magnetic permeability of the ferrite core decreases due to overheat. Furthermore, the air-core inductor attenuates the maximum amplitude of the standing wave of the fundamental wave of 2450 MHz, which is the greatest component of leaking waves, so as not to reach the core type inductor to alleviate load of the core type inductor.

[0006] The choke coil should be preferably large-sized in order to radiate the heat and to reduce the leakage power as mentioned above. However, the choke coil gets close to the inner wall of the filter box due to large-sizing and, as a result, electric discharge takes place, so that the filter box cannot be miniaturized.

[0007] The resistance R of the winding wire (coil) of the inductor is $R(\Omega)=\rho(L/A)$(ρ: $\Omega \cdot m$, L: length of winding wire (m), A: cross sectional area of winding wire (m^2)). When the diameter of the winding wire is decreased, the resistance of the winding wire is raised, so that the temperature of the choke coil rises. The cathode filament current supplied from an external power source is 9.0 to 12.0 A, and the current of leakage microwave is superposed thereon. Though it is possible to reduce the resistance upon shortening the length L of the winding wire in order to alleviate rise of the temperature, leakage of microwave increases because the inductance of the choke coil decreases. Moreover, if only the air-core type inductor is shortened, the standing wave of the fundamental wave of microwave has high amplitude at the position of the core type inductor, and as a result, the winding wire of the coil of the coil type inductor is damaged.

[0008] In addition, one of the factors which make operation of the magnetron tube instable is back heat (cathode inverse bombardment). Back heat is a phenomenon in which a part of thermal electrons emitted from the filament cathode returns to the filament by obtaining energy from the oscillating microwave. When the filament current during oscillation at a certain load is denominated by Ifb (ampere) while the filament current at the predetermined heater voltage applied thereto is denominated by If (ampere), the back-heat (%) is represented by $Ifb/If \times 100$ (%), which means that the number of electrons coming back to the cathode increase as the value of the back-heat decreases. Though the back-heat greatly varies in accordance with the output load, it is experientially desirable that the minimum value of the back-heat should be 90% or more for the magnetron structure mentioned above. The value can be maintained by making both the choke coil and the filter box large. However, the volume of the filter box is so large to the magnetron body that miniaturization thereof is prevented, and furthermore reduction of the cost of the choke coil is inhibited.

[0009] One object of the present invention is to provide a magnetron device with a desired back-heat value and fabricating a choke coil for magnetrons, which can miniaturize the filter box.

Summary of the Invention

[0010] A magnetron device of the present invention comprising,
a filter box disposed in order to cover a cathode terminal of a magnetron tube body,
a choke coil accommodated in the filter box, comprised of a core type inductor having a magnetic core and an air-core type inductor, both thereof being connected together serially, and the air-core type inductor being connected with the cathode terminal, and
a feed-through capacitor connected with the core type inductor of the choke coil, constituting a filter circuit together with the choke coil and penetrating the filter box; and
the wire's diameter of coils for the core type inductor and the air-core type inductor being 1.0 to 1.4 mm, the cross sectional area of the magnetic core being 5 to 16 mm^2, and
the number T of turns of the coil for the air-core type inductor being represented by

$$55<2\pi((D+A)/2)T\leq 90,$$

where A (mm) is the wire's diameter of the coil, and D (mm) is the diameter of the magnetic core.
[0011] The present invention is intended to make sure of a desired back-heat value and enable miniaturization of the filter box.

Brief Description of Drawings

[0012]

FIG. 1 is a cross sectional view of one example of the present invention.
FIG. 2 is a plan view inside the filter box, which is the FIG. 1 observed from II - II line in the direction of the arrows.
FIG. 3 is a schematic cross sectional view showing the filter box of one example of the present invention and that of a conventional structure with comparing to each other.
FIG. 4 contains curves of back heat (%) corresponding to the phases of output side and a table contrasting the core's diameter, the diameter of the coil, the number of turns of the air-core inductor, and the value of the formula (1) in the case of the example 1 and the comparative examples 2, 4.
FIG. 5 contains curves of back heat (%) corresponding to the phases of output side and a table contrasting the core's diameter, the diameter of the coil, the number of turns of the air-core inductor, and the value of the formula (1) in the case of the example 4 and the comparative examples 4.
FIG. 6 contains curves of back heat (%) corresponding to the phases of output side and a table contrasting the core's diameter, the diameter of the coil, the number of turns of the air-core inductor, and the value of the formula (1) in the case of the examples 3, 6 and the comparative examples 3.
FIG. 7 contains curves of back heat (%) corresponding to the phases of output side and a table contrasting the core's diameter, the diameter of the coil, the number of turns of the air-core inductor, and the value of the formula (1) in the case of the examples 3, 7 and the comparative examples 5, 6.

Detailed Description of the Invention

[0013] Some embodiments of the present invention will be explained hereinafter referring to the drawings. FIG. 1 is a cross sectional view of a magnetron used for microwave ovens. The anode portion 11 comprises the anode cylinder 12 and a plurality of vanes 13 which are protruded from the inner peripheral surface of the anode cylinder 12 toward the tube axis.
[0014] The cathode portion 14 is disposed on the tube axis m of the magnetron, and comprises the filament 15, the cathode center lead 18 and the cathode side lead 19 connected to both ends of the filament via the end hats 16, 17 respectively. The end of the vane is disposed so as to maintain a predetermined clearance to the filament 15, and the annular space 23 of the predetermined clearance forms an interaction space. A pair of funnel-like or cone-shaped pole pieces 20, 21 are provided face to face to each other on both ends of the anode cylinder 12 in the direction of the tube axis so as to interpose the interaction space. Moreover, the input portion 30 to supply a current for feeding the filament and a high voltage for driving the magnetron and the output portion 40 including the antenna lead 41 in order to transmit and emit microwaves are provided outside the pole pieces 20, 21 in each direction of the tube axis m to constitute the

magnetron body 10. One end of the antenna lead 41 is connected to one of the vanes 13 of the anode structure and the other end thereof is extended to the outside along the tube axis.

[0015] In addition, a pair of annular permanent magnets 50, 51 of ferrite supply a magnetic field to the interaction space 23 that is formed between the vanes 13 and the filament 15 through the magnetic circuit which is constituted of a pair of pole pieces 20, 21 connected magnetically to one surface of the pole piece and frame-like horseshoe yokes 52, 53 of ferromagnetic material connected magnetically to the other surface of the pole piece.

[0016] FIG. 2 shows the filter box 31 covering the input portion 30 of the magnetron and the inside of the filter box. The input portion 30 is constituted of the ceramics stem 32 holding the cathode center lead 18 and the cathode side lead 19, and the cathode terminals 33, 33 connected to the leads respectively. The 2-terminal feed-through capacitors 34, 34 are mounted on the wall portion of the filter box, and the choke coils 35, 35 are serially connected between the cathode terminals 33, 33 positioned at the central part of the filter box 31 and the feed-through capacitors 34, 34 respectively. Thus, the filter circuit is composed of the capacitors and the choke coils. A pair of choke coils 35, 35 have a structure of a single layered solenoid in which the core type inductor 36 comprising a coil having a columnar magnetic core 36a of such as ferrite is serially connected with the air-core type inductor 37 comprising an air-core coil. The air-core type inductor 37 side thereof is connected to the cathode terminal 33 via the bent wiring 38 of a predetermined length, and the core type inductor 36 side thereof is connected to the terminal 34a of the feed-through capacitor 34.

[0017] In the configuration mentioned above, out of microwaves leaking through the cathode terminals 33, 33, the fundamental wave component of 2450 MHz is the maximum. The length of the choke coil including the bent wiring 38 is determined in order that the position corresponding to 1/4 of the wavelength of the fundamental wave or the position where the amplitude of the leaking microwave becomes the maximum may be disposed in the air-core type inductor 37, sparsely wound in space between wires. In this case, many of the leaking microwaves are absorbed by the air-core type inductor 37. Because the air-core type inductor can be cooled by using ambient air etc., exothermic heat of the core type inductor is suppressed upon separating the maximum exothermic part of the air-core type inductor portion from the core type inductor 36, so that the inductance of the choke coils can be prevented from being decreased.

[0018] The present invention is set to be the wire's diameter of coils for the core type inductor and the air-core type inductor being 1.0 to 1.4 mm, the cross sectional area of the magnetic core being 5 to 16 mm^2, and the relationship to the number T of turns of the air-core type coil being

$$55<2\pi((D+A)/2)T\leq 90 \text{ ---------- } (1),$$

where A (mm) is the wire's diameter of the coil, and D (mm) is the diameter of the magnetic core.

[0019] The reason why the wire's diameter of the air-core type inductor is set to be 1.0 to 1.4 mm is that the electric resistance is raised and temperature rises if the wire's diameter is thin, and on the contrary, the thick diameter does not contribute to miniaturization of the coil and incurs rising of the cost. Upon setting the diameter thereof to be not more than 1.4 mm in accordance with the present invention, the characteristic thereof equivalent to that of the conventional coil can be preserved, and furthermore, a miniaturized choke coil can be obtained.

[0020] The reason why the cross sectional area of the magnetic core for the core type inductor is set to be 5 to 16 mm^2 is that the density of the magnetic flux is raised and gets to the saturation flux that deteriorates noise characteristic, moreover the back-heat value worsens if the cross sectional area becomes small i.e. not more than 5mm^2. Furthermore, productivity of thin cores is deteriorated because the core made of ferrite is mechanically fragile. Enlarging the cross sectional area cannot contribute to miniaturization of the coil. Usually, the air-core type inductor and the core type inductor are integrally formed with a cupper wire of the same diameter, and the inner diameter of each coil is the same. Combining each coil with an inner diameter different from each other can also be available. The cross sectional area of 5 to 16 mm^2 of the magnetic core corresponds to the diameter (D) of 2.5 to 4.5 mm of the columnar magnetic core that is substantially the same as the inner diameter of the coil.

[0021] The lower limit 55 of the formula (1) regulates the range where an appropriate back-heat characteristic can be obtained, and the upper limit 90 is a practical value to get away from large-sizing of the choke coil.

[0022] According to the example, the wire's diameter of the coil can be made thinner than the conventional structure and the cross sectional area of the columnar ferrite core constituting the magnetic core can be reduced, so that the length of the coil winding the core type inductor 36 can be shortened and the inductance thereof can be made equal to the conventional structure having a large coil diameter. In addition, effect on the core type inductor is decreased by positioning the maximum amplitude portion of the standing wave of leaking microwaves in the air-core type inductor 37 and at a point apart from the core type inductor in order that the amplitude thereof may become small at the point 37a that connects to the core type inductor 36.

[0023] The example will be explained hereinafter. For each example, the air-core inductor is sparsely wound, in which the interval between the coil wires thereof being not more than 1 mm, and the coil of the core type inductor is densely wound. The distance between both the above coils is 3mm. Sparse winding of the air-core inductor is to suppress temperature rising by air cooling, but expanding the interval between the coil wires too much results in large sizing of the choke coil. Therefore, the interval between the coil wires is preferably not more than 1 mm.

[0024] (Example 1) The diameter A of the winding wire = 1.4 mm, the number T of turns of the air-core type inductor = 3, and the diameter of the ferrite core for the core type inductor = 4.5 mm (cross sectional area = 15.90 mm^2) is fabricated. The inner diameters of the air-core type inductor and the core type inductor are the same i.e. 4.5 mm. In this case, $2\pi((D+A)/2)T$ in the formula (1) is 91.6, which satisfies the formula (1).

[0025] (Example 2) The diameter A of the winding wire = 1.0 mm, the number T of turns of the air-core type inductor = 5, and the diameter of the ferrite core for the core type inductor = 3 mm (cross sectional area = 7.065 mm^2) is fabricated. The inner diameters of the air-core type inductor and the core type inductor are the same i.e. 3 mm. In this case, $2\pi((D+A)/2)T$ in the formula (1) is 62.8.

[0026] (Example 3) The diameter A of the winding wire = 1.2 mm, the number T of turns of the air-core type inductor = 5, and the diameter of the ferrite core for the core type inductor = 3 mm (cross sectional area = 7.065 mm^2) is fabricated. The inner diameters of the air-core type inductor and the core type inductor are the same i.e. 3 mm. In this case, $2\pi((D+A)/2)T$ in the formula (1) is 65.9.

[0027] (Example 4) The diameter A of the winding wire = 1.2 mm, the number T of turns of the air-core type inductor = 4, and the diameter of the ferrite core for the core type inductor = 4.5 mm (cross sectional area = 15.90 mm^2) is fabricated. The inner diameters of the air-core type inductor and the core type inductor are the same i.e. 4.5 mm. In this case, $2\pi((D+A)/2)T$ in the formula (1) is 71.6.

[0028] (Example 5) The diameter A of the winding wire = 1.4 mm, the number T of turns of the air-core type inductor = 4, and the diameter of the ferrite core for the core type inductor = 4.5 mm (cross sectional area = 15.90 mm^2) is fabricated. The inner diameters of the air-core type inductor and the core type inductor are the same i.e. 4.5 mm. In this case, $2\pi((D+A)/2)T$ in the formula (1) is 74.1.

[0029] (Example 6) The diameter A of the winding wire = 1.2 mm, the number T of turns of the air-core type inductor = 6, and the diameter of the ferrite core for the core type inductor = 3 mm (cross sectional area = 7.065 mm^2) is fabricated. The inner diameters of the air-core type inductor and the core type inductor are the same i.e. 3 mm. In this case, $2\pi((D+A)/2)T$ in the formula (1) is 79.1. (Example 7) The diameter A of the winding wire = 1.2 mm, the number T of turns of the air-core type inductor = 6, and the diameter of the ferrite core for the core type inductor = 3 mm (cross sectional area = 7.065 mm^2) is fabricated. The inner diameters of the air-core type inductor and the core type inductor are the same i.e. 3 mm. In this case, $2\pi((D+A)/2)T$ in the formula (1) is 79.1.

[0030] (Comparative example 1) The diameter A of the winding wire = 1.0 mm, the number T of turns of the air-core type inductor = 4, and the diameter of the ferrite core for the core type inductor = 3 mm (cross sectional area = 7.065 mm^2) is fabricated. In this case, $2\pi((D+A)/2)T$ is 50.2, which does not agree with the formula.

[0031] (Comparative example 2) The diameter A of the winding wire = 1.0 mm, the number T of turns of the air-core type inductor = 3, and the diameter of the ferrite core for the core type inductor = 4.5 mm (cross sectional area = 15.90 mm^2) is fabricated. $2\pi((D+A)/2)T$ is 51.8.

[0032] (Comparative example 3) The diameter A of the winding wire = 1.2 mm, the number T of turns of the air-core type inductor = 4, and the diameter of the ferrite core for the core type inductor = 3 mm (cross sectional area = 7.065 mm^2) is fabricated. $2\pi((D+A)/2)T$ is 52.8.

[0033] (Comparative example 4) The diameter A of the winding wire = 1.2 mm, the number T of turns of the air-core type inductor = 3, and the diameter of the ferrite core for the core type inductor = 4.5 mm (cross sectional area = 15.90 mm^2) is fabricated. $2\pi((D+A)/2)T$ is 53.7.

[0034] (Comparative example 5) The diameter A of the winding wire = 1.2 mm, the number T of turns of the air-core type inductor = 5, and the diameter of the ferrite core for the core type inductor = 2 mm (cross sectional area = 3.14 mm^2) is fabricated. $2\pi((D+A)/2)T$ is 50.8.

[0035] (Comparative example 6) The diameter A of the winding wire = 1.2 mm, the number T of turns of the air-core type inductor = 6, and the diameter of the ferrite core for the core type inductor = 2 mm (cross sectional area = 3.14 mm^2) is fabricated. $2\pi((D+A)/2)T$ is 60.3.

[0036] Table 1 shows values of the formula (1) and the minimum values of each back heat in the examples 1 to 7 and the comparative examples 1 to 6 mentioned above.

Table 1

choke coil	diameter D of ferrite core (mm)	diameter A of wire for winding wire (mm)	number T of turns of air-core type inductor	value of formula (1)	back heat (%)
example 1	4.5	1.4	3	55.6	91.6

(continued)

choke coil	diameter D of ferrite core (mm)	diameter A of wire for winding wire (mm)	number T of turns of air-core type inductor	value of formula (1)	back heat (%)
example 2	3	1	5	62.8	93.3
example 3	3	1.2	5	65.9	92.3
example 4	4.5	1.2	4	71.6	91.2
example 5	4.5	1.4	4	74.1	90.3
example 6	3	1.2	6	62.8	91.2
example 7	3	1.2	6	65.9	92.4
comparative example 1	3	1	4	50.2	89.7
comparative example 2	4.5	1	3	51.8	87.1
comparative example 3	3	1.2	4	52.8	89.2
comparative example 4	4.5	1.2	3	53.7	88.5
comparative example 5	2	1.2	5	50.2	81.7
comparative example 6	2	1.2	6	60.3	83.3

[0037] Back heat is a phenomenon in which electrons emitted from the filament cathode return to the cathode by the high frequency electric field and then heat inversely the cathode.

[0038] FIG. 4 to FIG. 7 show the change of the back heat value of one example in the above table 1, where a load is placed in a waveguide mounted on the output antenna as a condition of the output load to a magnetron for microwave ovens oscillating 2450 MHz, and the position of the load is varied from 170 mm to 250 mm. It corresponds to more than a round in the Rieke diagram so as to change the phase of the reflection wave.

[0039] FIG. 4 shows the graphed back heat values of the comparative examples 2, 4 and the example 1 where the diameters of the cores and the numbers of turns of the air-core inductors are the same together respectively but the diameters of the coil wires are different from each other. This proves that the back heat worsens if the diameters of the coil wires are decreased. On the basis of 90% that is desirable as the back heat value as shown in the figure, the comparative examples 2 and 4 are lower than the reference value and the example 1 is over the reference value. The value of the formula (1) for the example 1 is greater than 55. This shows that the example 1 maintains the back heat value of 90% for phase change of the load as shown in the figure, whereas the value is changed considerably for phase change in the comparative examples 2, 4 as it is partially over 90% but the minimum value thereof is lower than 90%. That is to say, the above indicates that operation of the magnetron tube is stabilized to phase change if the back heat value is greater than 90%.

[0040] FIG. 5 shows the comparative example 4 and the example 4, which have the same core's diameter of 4.5 mm and the same wire's diameter of 1.2 mm of the coil for the air-core type inductor, but different numbers of turns of the air-core type coil from one another. This shows that the back heat is ameliorated upon increasing the number of turns. The value of the example 4 is 71.6. FIG. 6 shows, in the same way, some examples (the comparative example 3, the example 3 and the example 6), in which both the core's diameter and the wire's diameter of the air-core type inductor are unchanged but the number of turns of the air-core type inductor is varied. The minimum value of the back heat is over 90% for the example 3 and the example 6 in comparison with the comparative example 3. Though the number of turns for the example 6 is larger than that for the example 3, the back heat value thereof is worse than that of the example 3. As compared to the example of FIG. 5, the number of turns is constrained in accordance with the diameter of the core. For instance, the minimum value of the back heat value becomes not greater than 90% when the number of turns for the example 6 is set to be 7. The value of the formula (1) in this case is 92. In addition, the length of the coil for the air-core inductor becomes lengthened.

[0041] FIG. 7 is a graph in which the example 3 and the example 7 both having the core's diameter of 3 mm are compared with the comparative example 5 and the comparative example 6 both having the core's diameter of 2 mm on the condition that the diameter of the winding wire of each air-core type inductor is the same i.e. 1.2 mm. In the case of the core's diameter of 2 mm (the cross sectional area of the core is 3.14 mm^2), the back heat value is extremely deteriorated. The comparative example 6 satisfies the formula (1), but does not fulfill the condition of the cross sectional area of the core. It is necessary for the core's diameter to be 2.5 mm or more (the cross sectional area of the core is 5 mm^2).

[0042] FIG. 3 is to explain the dimensional difference between the example and a conventional filter box, showing that the clearance to the inner wall of the box is changed depending upon difference of the dimension of the choke coil. The right side of the figure is the example and the left side of the figure is a conventional structure. In order to maintain the insulation distance B between the choke coil 35A and the wall surface of the filter box 31A accommodating the above in the conventional structure, it is necessary for B to keep 16 mm or more. Therefore, the width of the inner wall of the filter box becomes 42 mm if the coil's diameter of the choke coil 35A is to be conventionally normal 10mm. To the contrary, according to e.g. the example 2 of the present invention, the diameter of the choke coil 35 comes to be 5mm on the condition of 3 mm of the diameter of the ferrite core and 1 mm of the diameter of the winding wire for the coil, and then the clearance of the inner wall of the filter box 31 is diminished to be 37 mm.

[0043] The formula (1), which the inventors have originated as a mathematical expression, shows a choke coil's structure capable of operating stably upon obtaining the back heat of 90% or more when the wire's diameter of the choke coil is decreased to 1.0 to 1.4 mm and the cross sectional area of the magnetic core is reduced to 5 to 16 mm^2. Consequently, in accordance with the present invention, many effects such as high reliability of operation of the magnetron, suppression of temperature rising of the choke coil, miniaturization of the choke coil, reduction of cost about the choke coil, and miniaturization of the filter box can be obtained.

Claims

1. A magnetron device comprising,
a filter box disposed in order to cover a cathode terminal of a magnetron tube body,
a choke coil accommodated in the filter box, comprised of a core type inductor having a magnetic core and an air-core type inductor, both thereof being connected together serially, and the air-core type inductor being connected with the cathode terminal, and
a feed-through capacitor connected with the core type inductor of the choke coil, constituting a filter circuit together with the choke coil and penetrating the filter box;
characterized in that the coils for the core type inductor and the air-core type inductor have wire's diameters of 1.0 to 1.4 mm, the magnetic core has a cross sectional area of 5 to 16 mm^2, and
the coil for the air-core type inductor has number T of turns of represented by

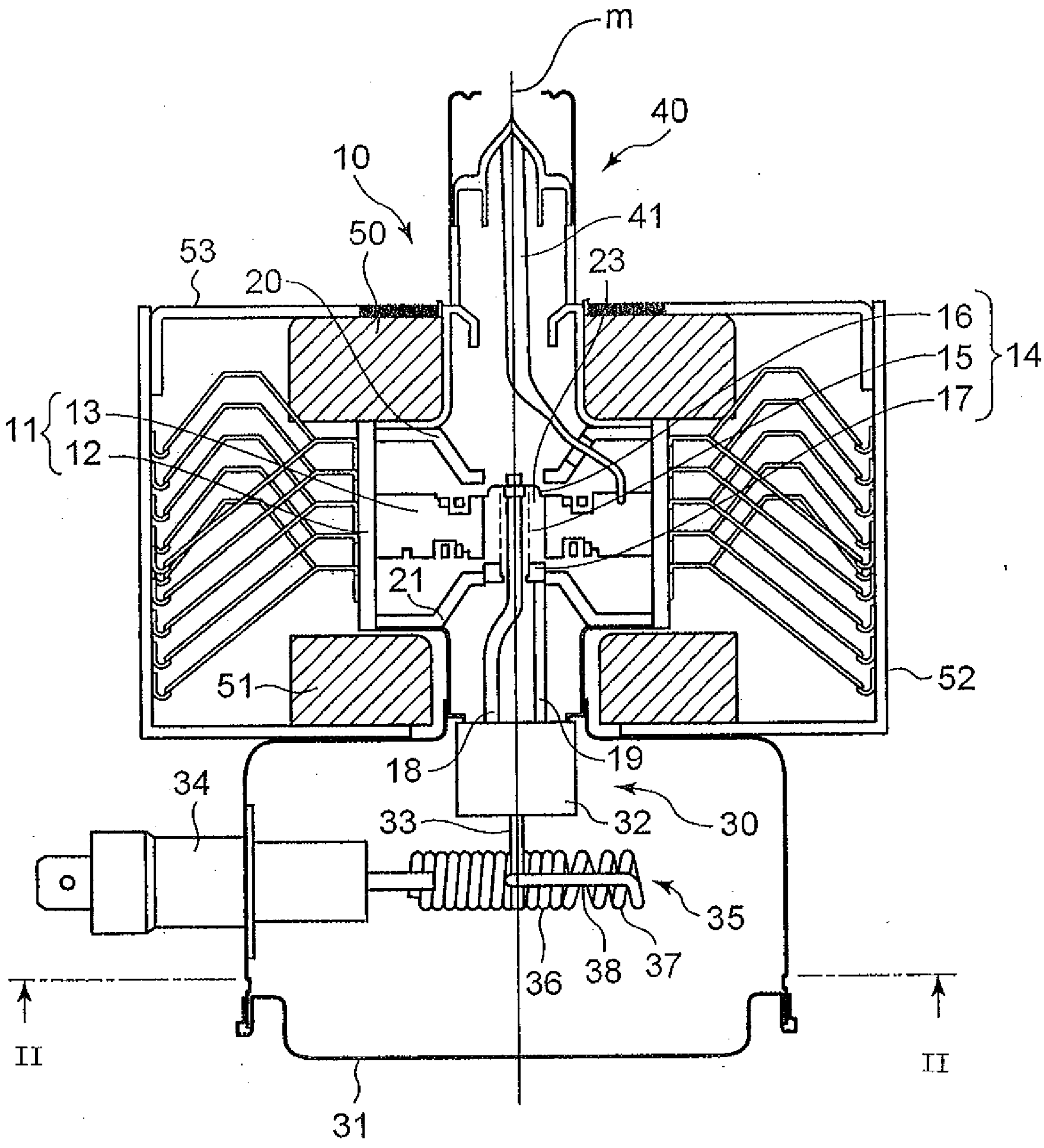
$$55<2\pi((D+A)/2)T\leq 90,$$

where A (mm) is the wire's diameter of the coil, and D (mm) is the diameter of the magnetic core.

2. The magnetron device as set forth in Claim 1, wherein the cathode terminal and the air-core inductor are connected together through a wiring, the length of the wiring is 20 to 25 mm, the air-core inductor being sparsely wound, and an interval between adjacent wires being not more than 1 mm.

3. The magnetron device as set forth in Claim 1 or 2, wherein the magnetic core is a ferrite core.

FIG. 1


m
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53
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14
17
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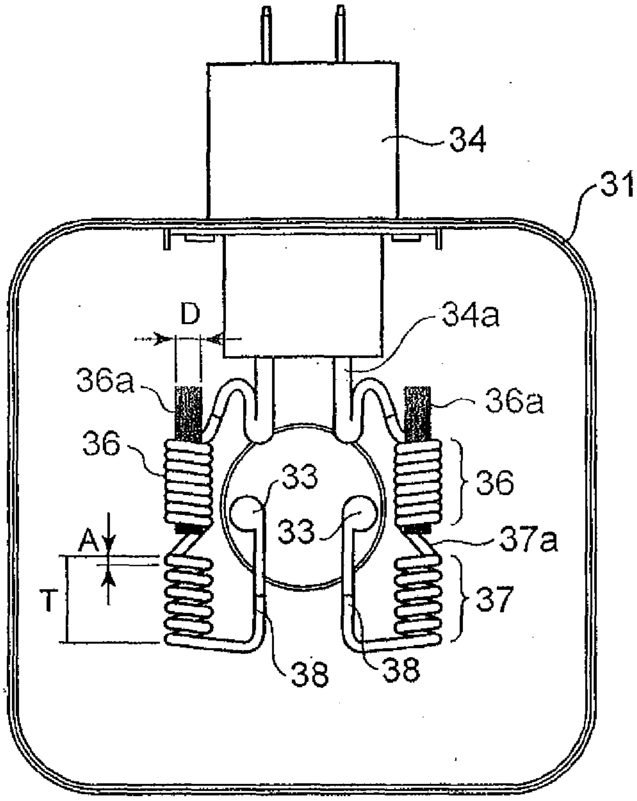
37
II
II
31

FIG. 2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31
D
34a
36a
36a
36
36
33
33
A
37a
T
37
38
38

FIG. 3

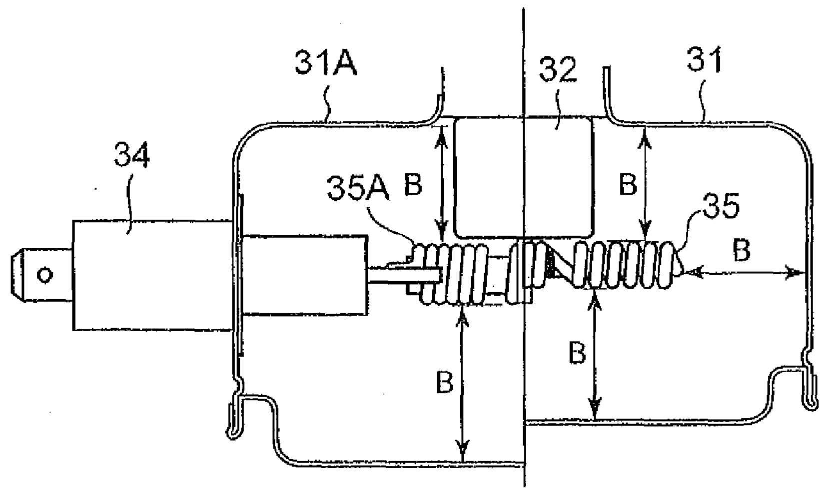
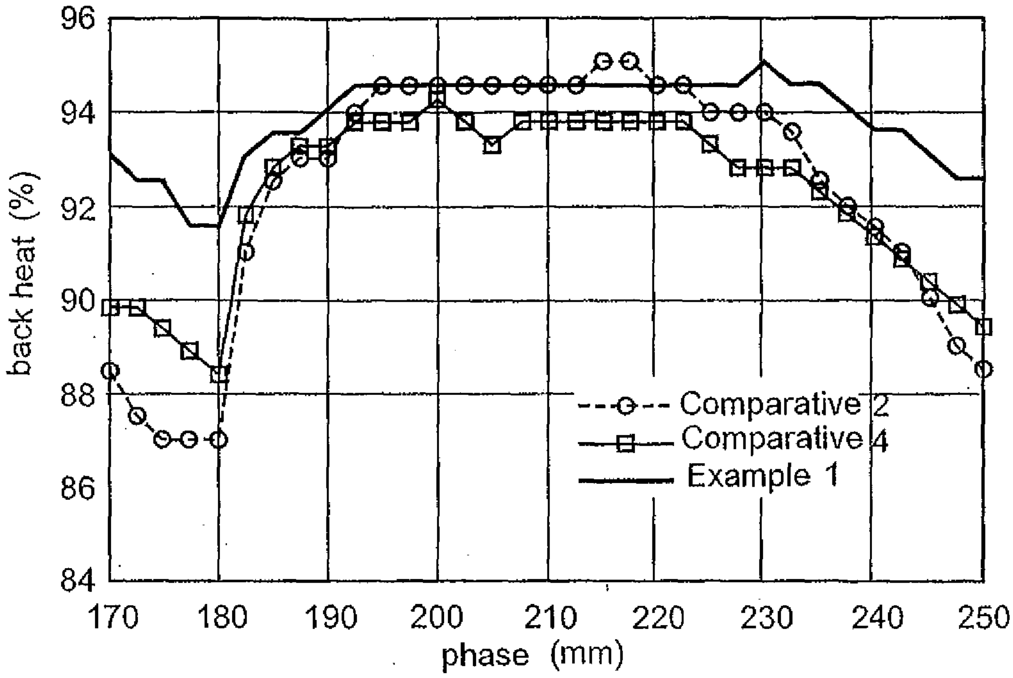
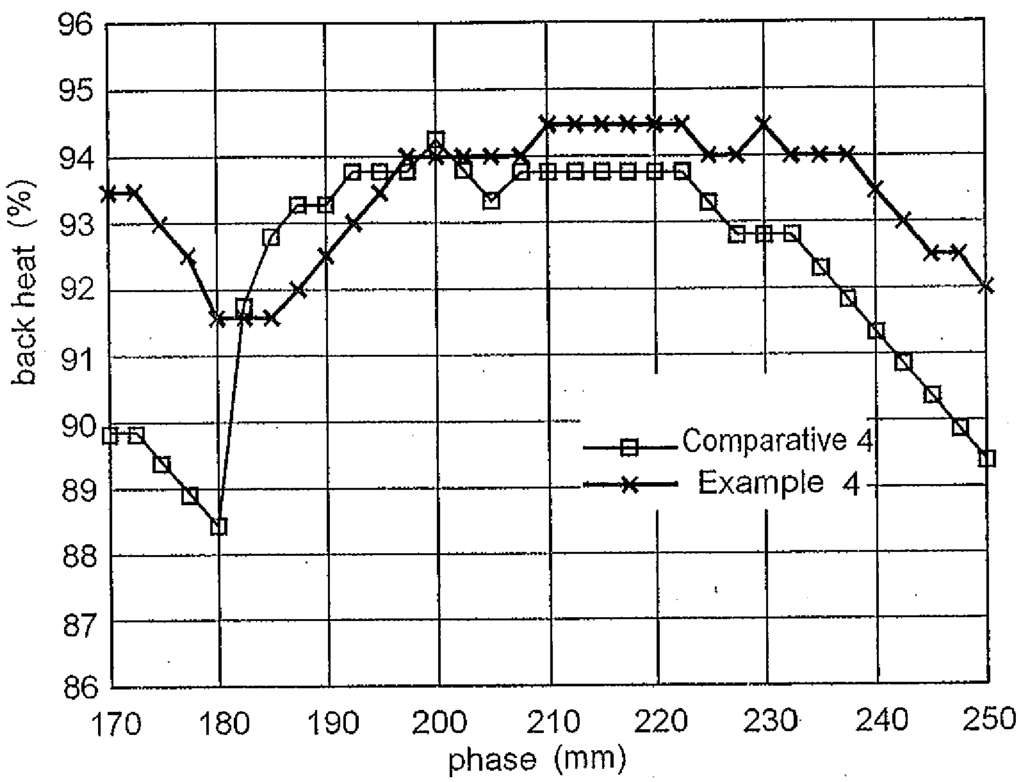

31A
32
31
34
35A
B
B
35
B
B
B

FIG. 4



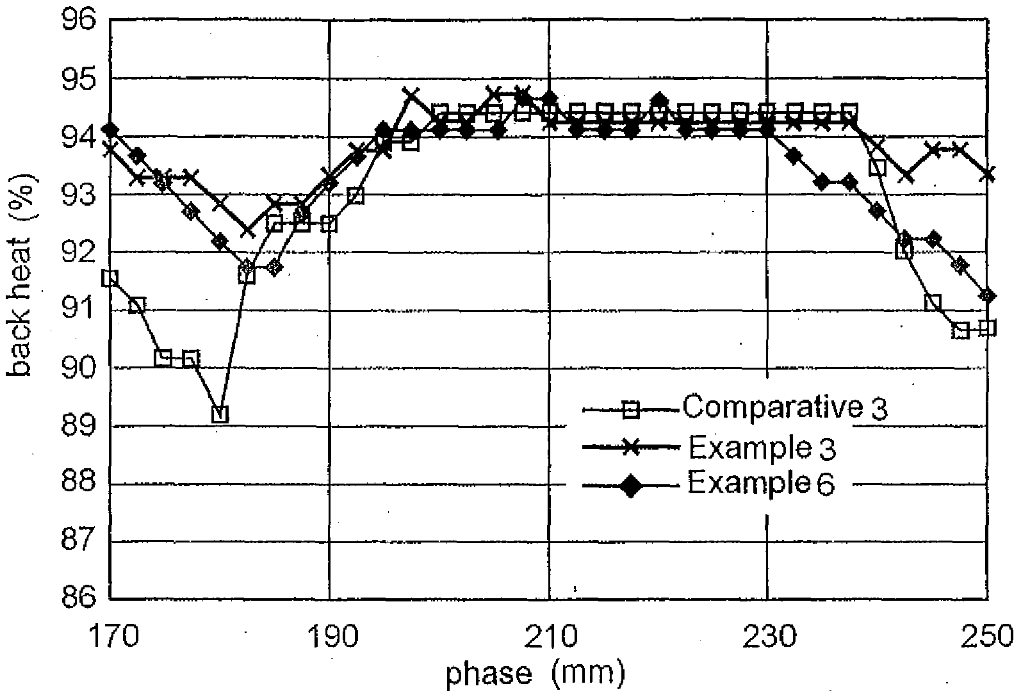
choke coil type No.	diameter of ferrite core D (mm)	diameter of wire for winding wire A (mm)	number of turns of air-core type inductor T(turn)	value of formula (1)
Comparative 2	4.5	1	3	51.8
Comparative 4	4.5	1.2	3	53.7
Example 1	4.5	1.4	3	55.6

FIG.5



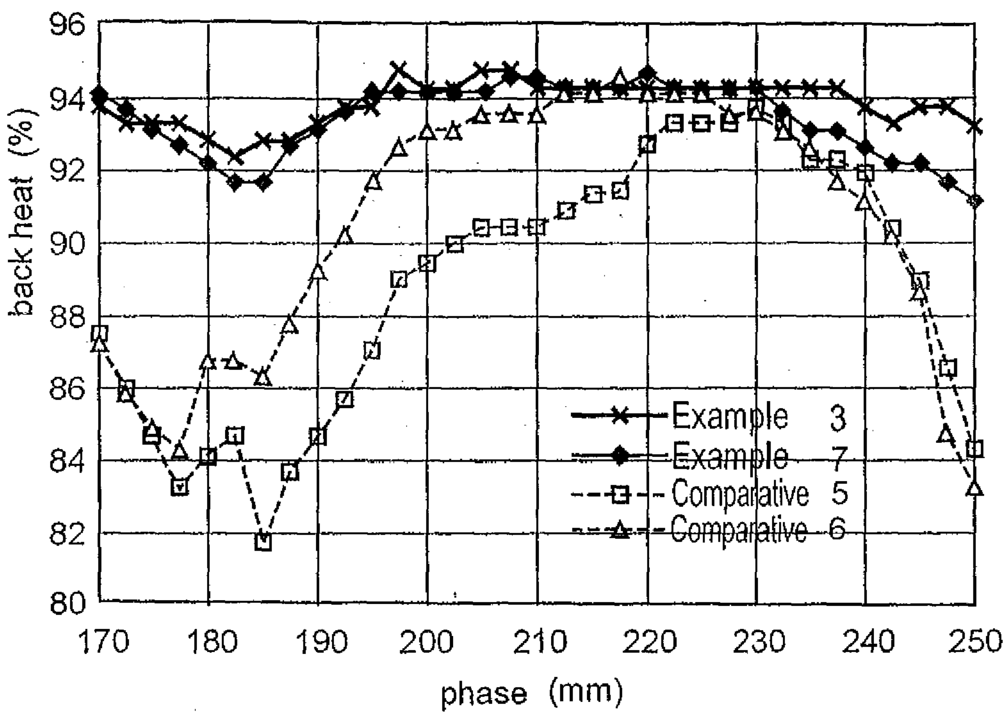
choke coil type No.	diameter of ferrite core D (mm)	diameter of wire for winding wire A (mm)	number of turns of air-core type inductor T(turn)	value of formula (1)
Comparative 4	4.5	1.2	3	53.7
Example 4	4.5	1.2	4	71.6

FIG. 6



choke coil type No.	diameter of ferrite core D (mm)	diameter of wire for winding wire A (mm)	number of turns of air-core type inductor T(turn)	value of formula (1)
Comparative 3	3	1.2	4	52.8
Example 3	3	1.2	5	65.9
Example 6	3	1.4	6	79.1

FIG. 7



choke coil type No.	diameter of ferrite core D (mm)	diameter of wire for winding wire A (mm)	number of turns of air-core type inductor T(turn)	value of formula (1)
Example 3	3	1.2	5	65.9
Example 7	3	1.2	6	79.1
Comparative 5	2	1.2	5	50.2
Comparative 6	2	1.2	6	60.3

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2002343263 A **[0004]**