United States Patent [19]

Tashiro

[11] **3,922,612**

[45] **Nov. 25, 1975**

[54] **MAGNETRON DEVICE**

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[73] Assignee: **Tokyo Shibaura Electric Co., Ltd.**, Kawasaki, Japan

[22] Filed: **Oct. 24, 1974**

[21] Appl. No.: **517,613**

[30] **Foreign Application Priority Data**

Nov. 12, 1973 Japan 48-127099

[52] **U.S. Cl.**... **328/230**; 219/10.55 B; 219/10.55 D; 315/39.51; 315/85; 331/86

[51] **Int. Cl.**^{2} **H01J 29/76**; H05B 9/02; H01J 25/50; H01J 1/52

[58] **Field of Search** .... 328/227, 330; 315/39.51, 315/39.53, 39.71, 85; 331/5, 86; 332/5; 219/10.55 R, 10.55 B, 10.55 D

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Primary Examiner—Alfred L. Brody

Attorney, Agent, or Firm—Oblon, Fisher, Spivak, McClelland & Maier

[57] **ABSTRACT**

A magnetron device, wherein a shield box is disposed on that side of a magnetron tube which faces a cathode stem; the shield box contains a choking system for preventing the leakage of microwave energy; and the choking system is formed of a pair of choking members, each of which has first and second choking elements, the first choking element being composed of a coil connected to a filament lead conductor and a high frequency core of high intrinsic resistivity received in the coil, and the second choking element being composed of a coil connected to the coil of the first choking element and a low frequency core of low intrinsic resistivity received in the second choking element coil.

10 Claims, 12 Drawing Figures

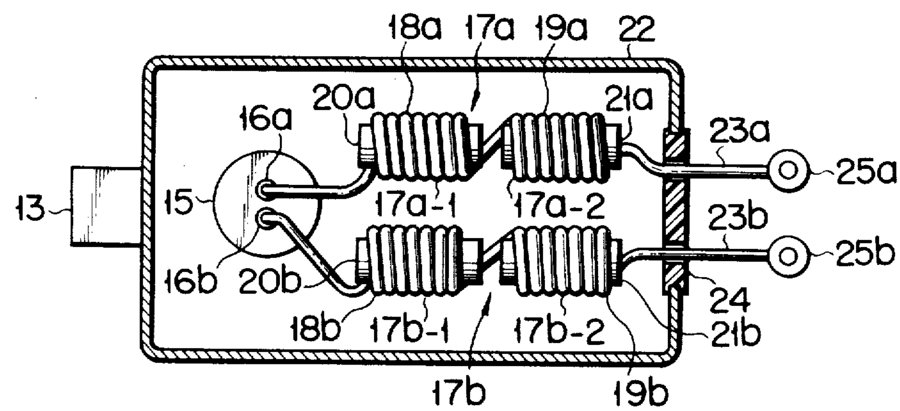


FIG. 1

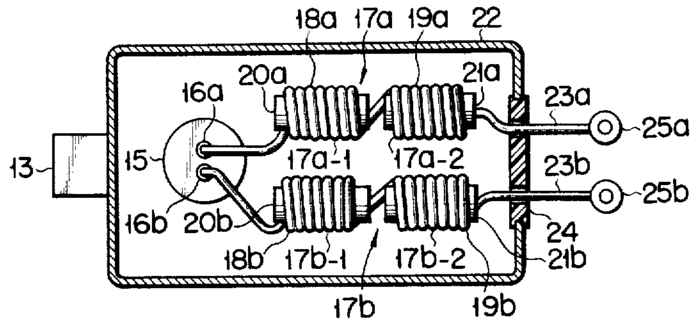


FIG. 2

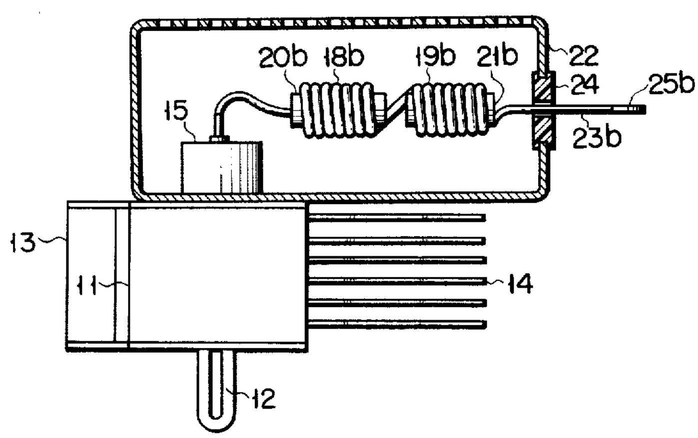


FIG. 3

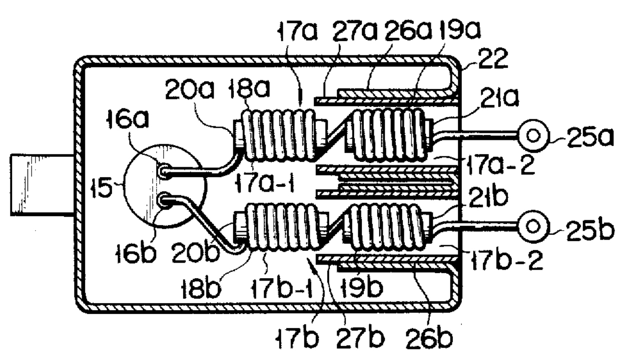


FIG. 4

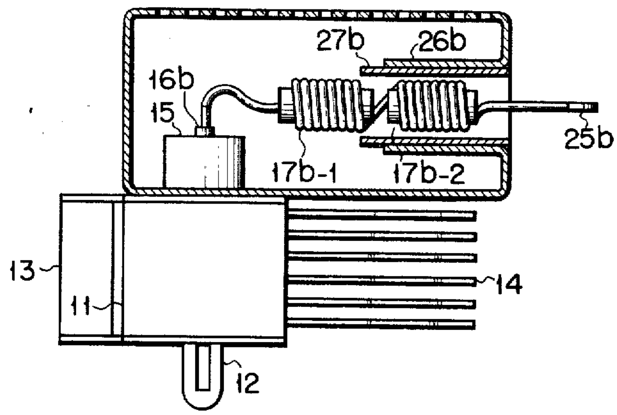


FIG. 5

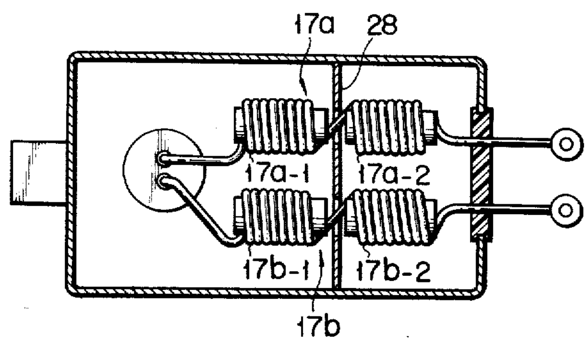


FIG. 6

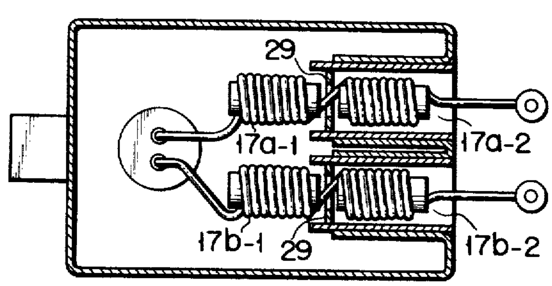


FIG. 7A

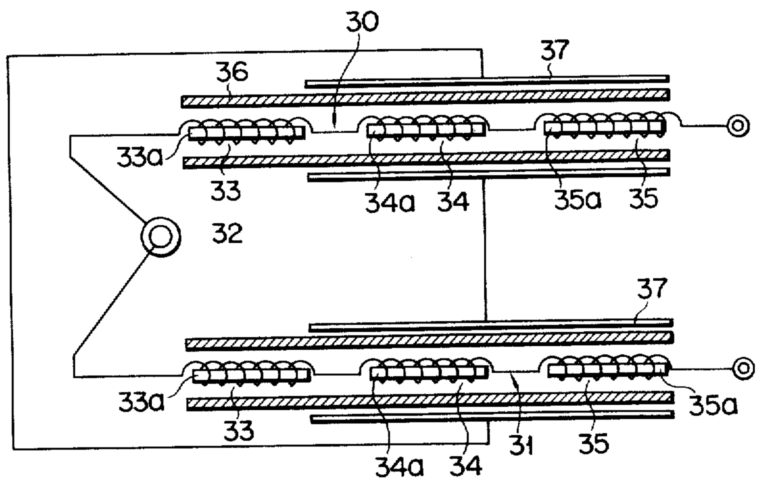


FIG. 7B

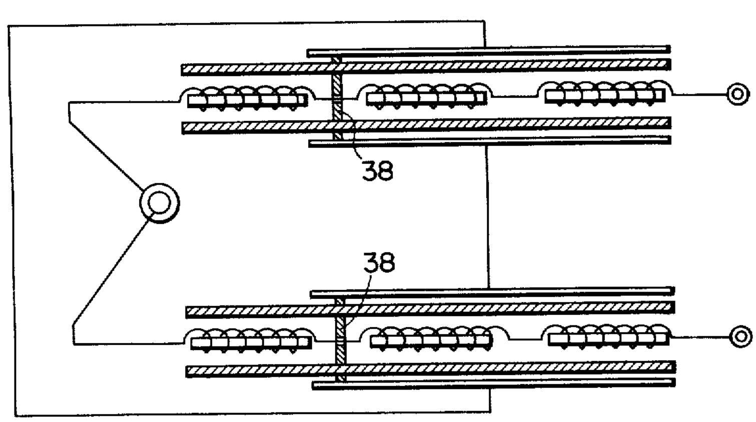


FIG. 8

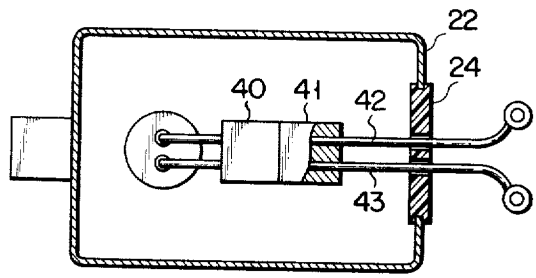


FIG. 9

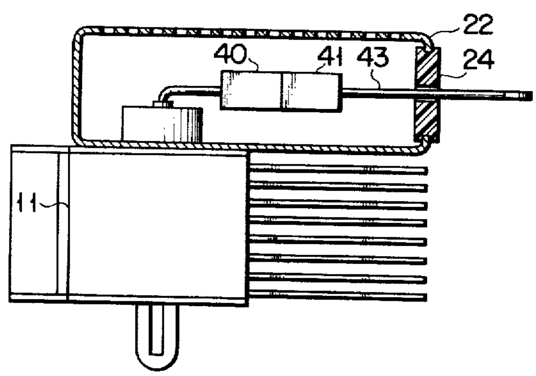


FIG. 10

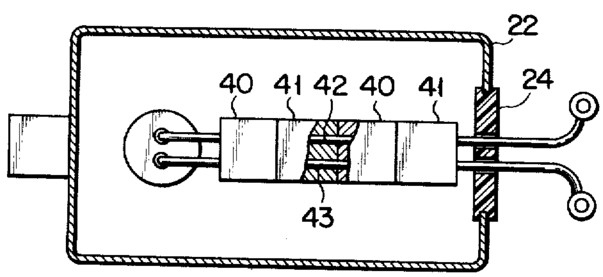
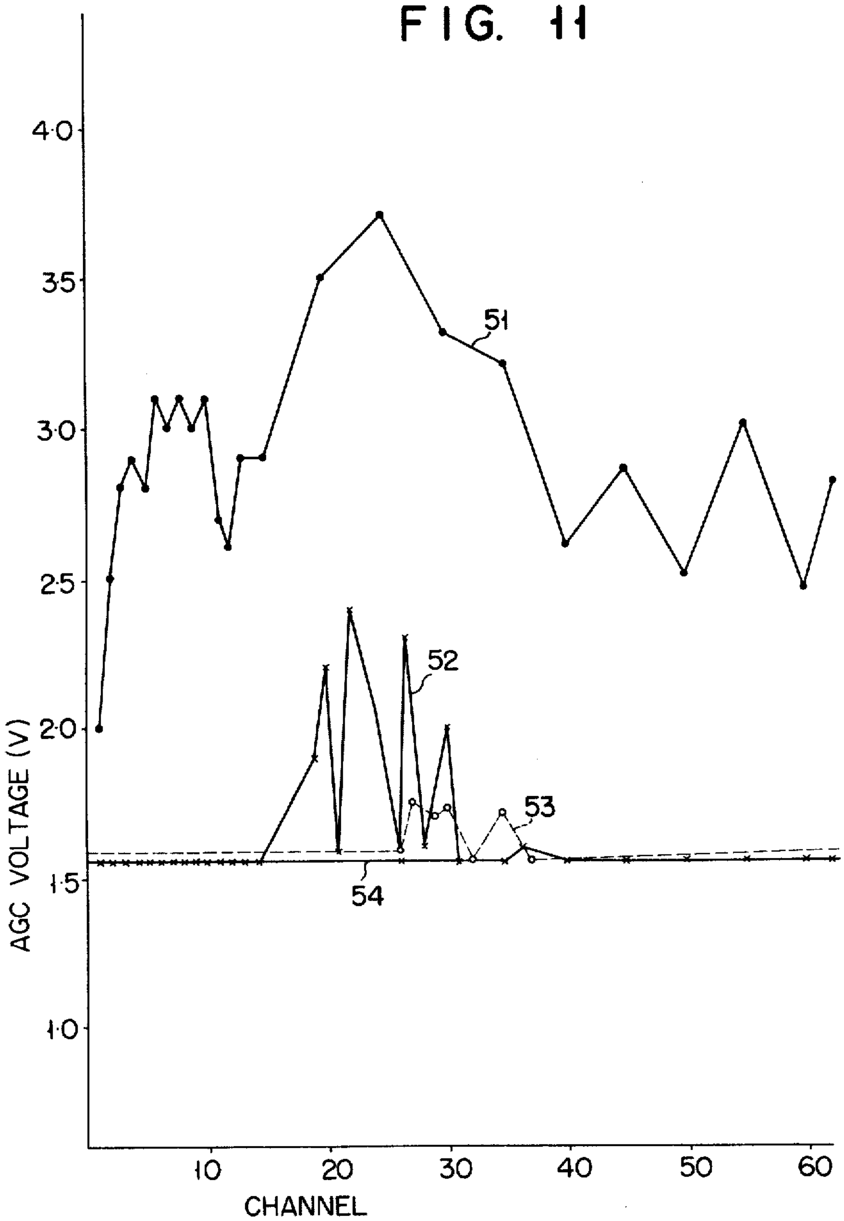


FIG. 11


4.0
3.5
3.0
2.5
2.0
1.5
1.0
AGC VOLTAGE (V)
51
52
53
54
10
20
30
40
50
60
CHANNEL

MAGNETRON DEVICE

This invention relates to a magnetron device and more particularly to a magnetron device improved in the choking circuit.

A magnetron is used incorporated in, for example, an electronic oven with its output antenna received in the closed chamber of the oven, for cooking, for example, food material by microwave energy delivered from the output antenna. When the magnetron is put into operation, a cathode bushing formed of, for example, ceramic material emits high frequency waves bearing the VHF and UHF bands. The above-mentioned type of magnetron which gives forth these high frequency waves disturbing a television receiving set is provided with a low pass filter to prevent their leakage.

A low pass filter for the prior art magnetron comprises a pair of choke coils each including a ferrite core and a capacitor penetrated by a pair of filament lead conductors. The cathode section of the prior art magnetron and the choke coils are sealed in a shield box so as to prevent the leakage of undesirable electromagnetic waves emitted from said cathode section. With such construction, the capacitor of the low pass filter must withstand the operating voltage of the magnetron, namely as high voltage as ten and odd kilovolts, resulting in the high cost of the capacitor and in consequence the magnetron device.

Another type of prior art magnetron device is provided with an L-C low pass filter utilizing a floating capacity and the inductance of an inductor composed of a plurality of series connected ferrite beads bored with two penetrating holes through which a pair of filament lead conductors are inserted. The L-C low pass filter of such magnetron, though producible at a low cost, is not fully effective to prevent the leakage of noise microwaves.

It is accordingly the object of this invention to provide a magnetron device using an inexpensive low pass filter capable of very effectively preventing the leakage of noise microwaves.

According to an aspect of this invention, there is provided a magnetron device, wherein a high frequency choking system is received in a shield box disposed on that side of the magnetron tube which faces a cathode stem; and said choking system is composed of a pair of choking members connected to a pair of filament lead conductors, each choking member being formed of at least one first choking element including a high frequency core of high intrinsic resistivity directly connected to a filament lead conductor and at least one second choking element including a low frequency core of low intrinsic resistivity connected to the first choking element.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawing, in which:

FIG. 1 is a plan view of a magnetron device according to an embodiment of this invention;

FIG. 2 is a side view of the magnetron device of FIG. 1;

FIG. 3 is a plan view of a magnetron device according to a second embodiment of the invention, wherein a shield is disposed near that of the cores of each choking member which is disposed on a power source side;

FIG. 4 is a side view of the second embodiment of FIG. 3;

FIG. 5 is a plan view of a magnetron device according to a third embodiment of the invention modified from FIG. 1, wherein a plate shield member is interposed between the first choking elements and the second choking elements of a pair of choking members;

FIG. 6 is a plan view of a magnetron device according to a fourth embodiment of the invention modified from FIG. 3;

FIG. 7A is a schematic plan view of a magnetron device according to a fifth embodiment of the invention, wherein each choking member includes a plurality of second choking elements;

FIG. 7B is a schematic plan view of a magnetron device according to a sixth embodiment of the invention, wherein a plate shield member is disposed between the first choking element and the adjacent second choking element of each choking member;

FIG. 8 is a plan view of a magnetron device according to a seventh embodiment of the invention, wherein a choking system composes two series connected ferrite core beads;

FIG. 9 is a side view of the seventh embodiment of FIG. 8;

FIG. 10 is a plan view of a magnetron device according to an eighth embodiment of the invention, wherein a choking system is formed of a plurality of series connected ferrite core beads;

FIG. 11 is a graph showing data of comparison between the noise characteristics of the prior art magnetron and that of the present magnetron, as obtained from the AGC voltage of a television receiver.

Referring to the first embodiment of FIGS. 1 and 2, a magnetron 11 is used, for example, in cooking food material by microwave energy emitted from an output antenna held in the closed oven chamber (not shown) of, for example, an electronic oven. The magnetron 11 is provided with a magnet 13 and radiator 14. The cathode bushing 15 of the magnetron 11 is provided with heater lead terminals or filament lead terminals 16*a*, 16*b*. A pair of choking members 17*a*, 17*b* are connected to these lead terminals 16*a*, 16*b* respectively. The choking member 17*a* comprises a pair of choking elements 17*a*-1, 17*a*-2 composed of series connected coils 18*a*, 19*a* and cores 20*a*, 21*a* inserted thereinto. Similarly, the choking member 17*b* comprises a pair of choking elements 17*b*-1, 17*b*-2 composed of series connected coils 18*b*, 19*b* and cores 20*b*, 21*b* inserted thereinto. The cores 20*a*, 20*b* are formed of NiZn-base ferrite (manufactured, for example, by Tokyo Denki Kagaku under a commercial name "Q_3C") having a prominent permeability to high frequency and a high intrinsic resistivity of more than 1 KΩ·cm, for example 10 KΩ·cm at a room temperature. The cores 21*a*, 21*b* are made of MnZn-base ferrite (manufactured, for example, by Tokyo Denki Kagaku under a commercial name "H_3S") having a prominent permeability to low frequency and a low intrinsic resistivity of less than 100 Ω·cm, for example 30 Ω·cm at a room temperature. The choking members 17*a*, 17*b* and cathode bushing 15 are received in a shield box 22. The leads 23*a*, 23*b* of the choking members 17*a*, 17*b* are connected to the terminals 25*a*, 25*b* through the insulation wall 24 formed at a part of the shield box 22.

Provision of the choking members 17*a*, 17*b* of the above-mentioned arrangement substantially prevents the leakage of objectionable noise microwaves of VHF and UHF bands emitted from the cathode bushing 15 during the operation of the magnetron 11, thereby keeping a television receiving set practically free from the effect of such noise microwaves. where

Where, therefore, noise microwaves are treated by the choking members **17**a, **17**b set at a mode capable of readily absorbing such noises, then the noise microwaves are prominently attenuated and least likely to leak to the outside. However, such mode is not realized if all the cores **20**a, **20**b, **21**a, **21**b of the choking members **17**a, **17**b are made of the same material. But only whre the cores **20**a, **20**b positioned near the cathode **15** of the magnetron **11** are made of material having a higher intrinsic resistivity than the cores **21**a, **21**b facing the power supply terminals **25**a, **25**b, then can be attained the above-mentioned mode, in which the undesirable noise microwaves can be easily absorbed by the choking members **17**a, **17**b, thereby substantially presenting the leakage of said noise microwaves.

According to a second embodiment of FIGS. **3** and **4**, the choking member **17**a comprises a choking element **17**a-**1** including a core **20**a of high intrinsic resistivity and a choking element **17**a-**2** including a core **21**a of low intrinsic resistivity. Similarly, the choking member **17**b comprises a choking element **17**b-**1** including a core **20**b of high intrinsic resistivity and a choking element **17**b-**2** including a core **21**b of low intrinsic resistivity. The choking element **17**a-**2** including the core **21**a of low intrinsic resistivity and the choking element **17**b-**2** including the core **21**b of low intrinsic resistivity are respectively surrounded by shield cylinders **26**a, **26**b into which the corresponding insulation silicon tubes **27**a, **27**b are inserted. This arrangement enables objectionable noise microwaves emitted from the cathode bushing **15** to be effectively absorbed.

If the foregoing embodiments are further modified by providing a prescribed space between the cores **20**a and **21**a of different intrinsic resistivities, as well as between the cores **20**b and **21**b of different intrinsic resistivities or interposing, as shown in FIGS. **5** and **6**, a metal shield plate **28** between the cores constituting said two groups so as to attain magnetic insulation therebetween, then noise microwaves can be more effectively absorbed.

Referring to the embodiments of FIGS. **7A** and **7B**, a choking member **30** comprises a first choking element **33** including a core **33**a of high intrinsic resistivity located near a cathode bushing **32** and a plurality of second choking elements **34**, **35** respectively including cores **34**a, **35**a of low intrinsic resistivity. Another choking member **31** has the same arrangement. Each of these choking members **30**, **31** is surrounded by a silicon tube **36**. The outer surface of that part of the silicon tube **36** which faces the plural second choking elements **34**, **35** is covered with an aluminium shield membrane **37**.

If, as shown in FIGS. 7 and **8**, each of the choking elements **30**, **31** comprises a first choking element **33** including a core **33**a of high intrinsic resistivity and disposed near the cathode bushing **32** and a plurality of second choking elements **34**, **35** including cores **34**a, **35**a of low intrinsic resistivity connected in series to the first choking element **33**, and the respective choking elements **33**, **34**, **35** are set at prescribed modes, then noise microwaves having a considerably broad band range can be effectively absorbed.

According to the embodiment of FIG. **7B**, a shield plate member **38** is further provided between the first choking element **33** and the adjacent second choking element **34**.

Referring to the embodiment of FIGS. **8** and **9**, the choking member comprises a ferrite core bead **40** of high intrinsic resistivity and a ferrite core bead **41** of low intrinsic resistivity which are respectively bored with two penetrating holes and aligned to each other in series, and a pair of heater or filament leads **42**, **43** passing through said holes. In this case, the paired filament leads **42**, **43** act as the choking coils described in the foregoing embodiment. These filament leads **42**, **43** and ferrite core beads **40**, **41** form choking members. Such choking member is of simple arrangement and can be made compact.

According to the embodiment of FIG. **10**, the choking member comprises a plurality of groups of alternately connected ferrite core beads **40**, **41**, each being of the same type as described above. A pair of filament leads **42**, **43** are inserted through the penetrating holes bored in said ferrite core beads. The arrangement of the choking member shown in FIG. **10** can absorb noise microwaves having a considerably broad band range.

Examination of the effect exerted by the noise microwaves emitted from an electronic oven equipped with a magnetron, for example, on a television receiving set can be conveniently carried out by measuring changes in the AGC voltage of said receiving set. FIG. **11** graphically sets forth the data obtained from this test method. The curve **51** indicates changes in the AGC voltage of a television receiving set caused by noise microwaves emitted from a magnetron-type electronic oven omitting a filter. The curve **52** shows changes in the AGC voltage of a television receiving set caused by noise microwaves leaking from an electronic oven using a magnetron device according to the embodiment of FIGS. **1** and **2**. The curve **53** denotes changes in said AGC voltage resulting from noise microwaves discharged from an electronic oven containing a magnetron device according to the embodiment of FIG. **7A**. The curve **54** illustrates changes in the AGC voltage arising from noise microwaves emitted from an electronic oven provided with a magnetron device according to the embodiment of FIG. **7B** wherein a shield plate **38** is provided between the first choking element **33** including the core **33**a of high intrinsic resistivity and the second choking element **34** including the core **34**a of low intrinsic resistivity. As apparent from FIG. **11** a noise microwave-absorbing filter utilizing the choking member of this invention has a far higher filtering effect and is much more inexpensive than the prior art filter.

Each of said choking members may comprise at least one choking element formed of a ferrite core and a choking coil wound about said ferrite core; and at least one more choking element constituted by a ferrite core bead in which a lead conductor connected to said choking coil is received.

What is claimed is:

1. A magnetron device comprising a magnetron body; means for applying a magnetron field to the magnetron body; a cooling device fitted to the magnetron body; a shield box disposed on that side of the magnetron body which faces a cathode stem; and a noise microwave-absorbing filter received in the shield box, wherein the noise microwave-absorbing filter is composed of a pair of choking members respectively connected to heater lead conductors; each choking member is composed of at least one first choking element including a first ferrite core of high intrinsic resistivity connected to the heater lead conductor and at least one second choking element including a second ferrite core of low intrinsic resistivity connected in series to the first choking element.

2. A magnetron device according to claim 1, wherein the first ferrite core is made of a NiZn-base high frequency core, and the second ferrite core is formed of a MnZn-base low frequency core.

3. A magnetron device according to claim 1, wherein the paired choking members are used at a maximum ambient temperature of 150°C.

4. A magnetron device according to calim 1, wherein each of the paired choking members comprises the first choking element including a first coil wound about the first core and connected at one end to the heater lead conductor and the second choking element including a second coil wound about the second core and connected to the other end of the first coil of the first choking element.

5. A magnetron device according to claim 4, wherein the second choking element is surrounded by a shield member.

6. A magnetron device according to claim 5, wherein the shield member receives an insulation tube.

7. A magnetron device according to claim 1, wherein each of the paired choking members includes a plurality of series connected second choking elements.

8. A magnetron device according to claim 1, wherein a shield plate member is provided between the first choking element and the adjacent second choking element.

9. A magnetron device comprising a magnetron body; means for applying a magnetic field to the magnetron body; a cooling device fitted to the magnetron body; a shield box disposed on that side of the magnetron body which faces a cathode stem; and a noise microwave-absorbing filter received in the shield box, wherein the noise microwave-absorbing filter is composed of a pair of choking members respectively connected to a pair of heater lead conductors; each of the paired choking members is composed of a first choking element including a first coil connected at one end to the heater lead conductor and a first ferrite core of high intrinsic resistivity inserted into the first coil and a plurality of second choking elements including a plurality of second coils connected in series to the first coil of the first choking element and a plurality of second ferrite cores of low intrinsic resistivity inserted into the plural second coils; the first choking element and the plural second choking elements of each choking member are surrounded by a silicon tube; that part of the silicon tube which faces the plural choking elements is enclosed in a shield cylinder; and a shield plate member is provided between the first choking member and the adjacent second choking member.

10. A magnetron device comprising a magnetron body; means for applying a magnetic field to the magnetron body; a cooling device fitted to the magnetron body; a shield box disposed on that side of the magnetron body which faces a cathode stem; and a noise microwave-absorbing filter received in the shield box, wherein the noise microwave-absorbing filter includes at least one first ferrite core bead of high intrinsic resistivity bored with a pair of penetrating holes and disposed on that side of the magnetron body which faces the cathode stem; at least one second ferrite core bead of low intrinsic resistivity bored with a pair of penetrating holes and positioned adjacent to the first ferrite core bead; and a pair of conductors passing through the paired penetrating holes of the first and second ferrite core beads to be connected to a pair of heater leads fitted to the cathode stem of the magnetron body.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,922,612

DATED : November 25, 1975

INVENTOR(S) : Norio Tashiro

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 1, line 2, please delete "magnetron field" and insert therefor --magnetic field--.

Signed and Sealed this

twenty-second **Day of** *June 1976*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks