United States Patent

[11] **3,575,632**

[72] Inventors **Yoshio Kato**
Minoo-shi;
Yasuo Ishida, Hirakata-shi, Japan

[21] Appl. No. **757,901**
[22] Filed **Sept. 6, 1968**
[45] Patented **Apr. 20, 1971**
[73] Assignee **Matsushita Electronics Corporation**
Osaka, Japan
[32] Priority **Sept. 7, 1967**
[33] **Japan**
[31] **42/57759**

[54] **COOLING ARRANGEMENT FOR MAGNETRON**
5 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **315/32,** 165/185, 219/10.55, 313/45, 315/39.51, 317/100
[51] **Int. Cl.** **H01j 7/26,** H05b 9/06
[50] **Field of Search** .... 313/11, 30, 42, 45, 46; 315/39.51, 39.67; 219/10.55; 165/185; 165/(E); 315/39.71; 331/69

[56] **References Cited**

UNITED STATES PATENTS

3,304,400	2/1967	Ojelid	313/45X
3,323,020	5/1967	Lenart et al.	219/10.55X

FOREIGN PATENTS

855,272	11/1960	Great Britain	313/45

Primary Examiner—Robert Segal
Assistant Examiner—E. R. LaRoche
Attorney—Stevens, Davis, Miller and Mosher

ABSTRACT: A magnetron device composed by improving the medium or large size magnetron device having an output power of the order of 500 watts in ultrahigh frequency, which comprises as cooling means an assembly of a natural air-cooled type radiator formed of aluminum or alloy thereof and which, accordingly, does not necessitate the cooling means like blowers provided to conventional devices. Said device has such advantages that noise is eliminated during operation and that it is light and compact and therefore it is particularly suitable for a domestic-use microwave range.

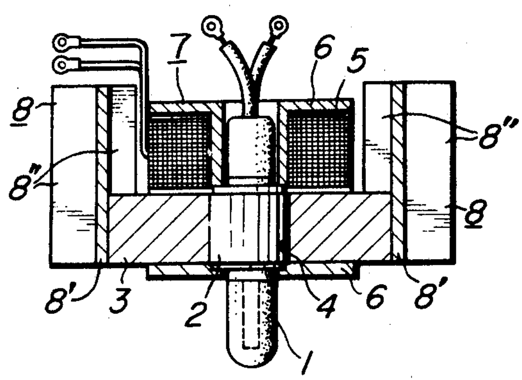


FIG. 1

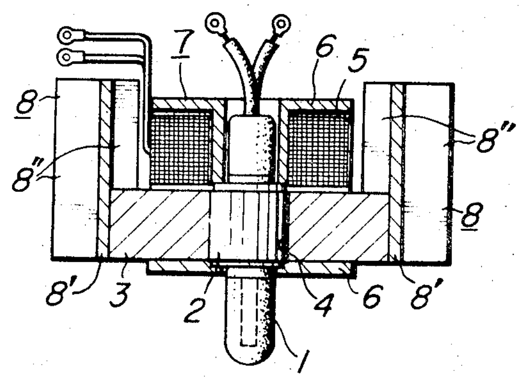
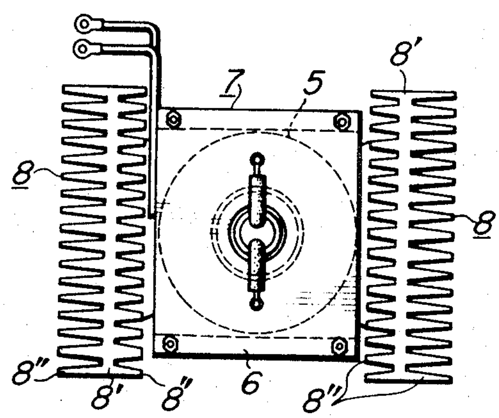


FIG. 2



INVENTORS
YOSHIO KATO
YASUO ISHIDA

BY Stevens, Davis, Miller & Mosher
ATTORNEYS

FIG. 3

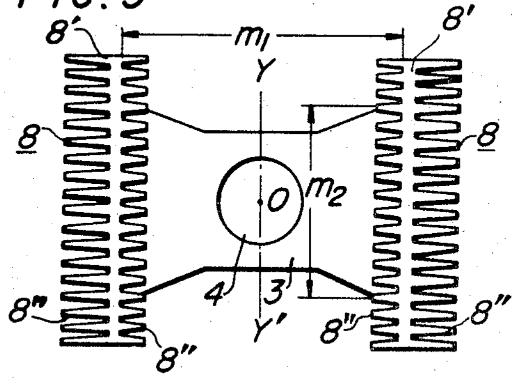
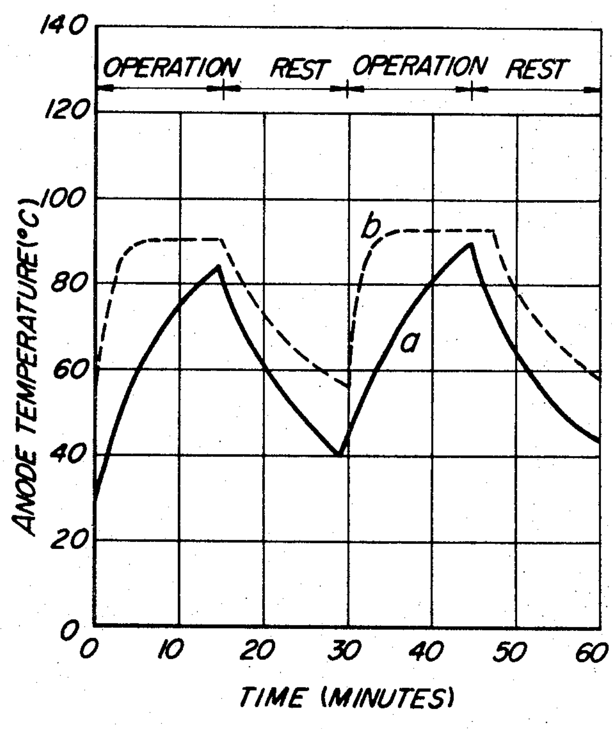


FIG. 4



INVENTORS
YOSHIO KATO
YASUO ISHIDA

BY Stevens, Davis, Miller & Mosher

ATTORNEYS

COOLING ARRANGEMENT FOR MAGNETRON

This invention relates to the improvement of a natural air-cooled type magnetron device.

In a continuous-wave magnetron device composed by installing a medium or large size magnetron tube body having an output power of about 500 watts in ultrahigh frequency, a forced air-cooling system has been employed as means to cool the magnetron tube. Namely, the exterior part of the tube including the anode of the magnetron is disposed in the air duct and a blower is provided at one end of the air duct to dissipate the anode heat generated by the anode loss of the magnetron device.

According to such forced air-cooling method, however, not only the mechanism of the cooling system becomes large and complicated, but also indirect costs are expensive to operate the blower and the noise of the blower is offensive to the ear.

A so-called natural air-cooled type device, which does not comprise said blower as cooling means for the conventional magnetron device, but comprises radiator fins provided directly to the anode of the magnetron, is also used in a small output magnetron device. According to said structure, however, it is only possible to cool magnetron devices of output power of about 200 watts in ultrahigh frequency.

This invention is intended to obviate the above deficiencies present in the conventional magnetron device and an object of this invention is to provide a magnetron device comprising natural air-cooled type radiation means which can cool a medium or a large size magnetron device of an output power of the order of 500 watts in ultrahigh frequency.

Another object of this invention is to provide a natural air-cooled type magnetron device having a good radiation ability.

A further object of this invention is to provide a natural air-cooled type magnetron device with a compact packaged radiator and a magnetic field generator simple to assemble and useful for a domestic-use microwave range.

The magnetron device according to this invention comprises a body of an electron tube capable of microwave generation, a magnetic field generator coupled magnetically thereto and a natural air-cooled type radiator directly connected to the anode of said electron tube body and it is characterized in that said radiator is composed by assembling a disc core and a large number of radiator fins wherein said core part is closely adhered to said body of the electron tube at the center and fixed to said radiator fins at the end of said core part. Said radiator has the heat conduction characteristics to radiator fins that the temperature difference between the central hole part and the end part of the disc core is kept less than 50° C. during operation. Said radiator is formed of a light metal having good thermal conductivity like aluminum or alloy thereof. In this magnetron device, the disc core composing a part of said radiator has a main surface, the form of which is rectangular or modified-rectangular, perpendicular to the axis of said magnetron tube, said magnetic field generator is provided on said main surface and in the side space outside the end part perpendicular to the short side of said main surface and radiator fins composing the principal component of the radiator of said device are fixed on both end parts perpendicular to the long side of said main surface and disposed at the circumference surrounding said magnetron tube body and said magnetic field generator.

In the magnetron device of this invention, the disc core of the radiator has a practical dimension such that the weight thereof is about 20 percent—60 percent of the total weight of the radiator.

Other objects, features and advantages of this invention will be readily apparent from the following detailed description of certain preferred embodiments taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a fragmentary sectional diagram of a natural air-cooled type magnetron device embodying this invention;

FIG. 2 is a plan view of a natural air-cooled type magnetron device embodying this invention;

FIG. 3 is a plan view of a radiator structure of a magnetron device of this invention; and

FIG. 4 shows the thermal characteristics of a magnetron device of this invention during a typical intermittent operation and shows the variation of the anode temperature with time.

In FIGS. 1 and 2, reference numeral 1 designates a medium size magnetron of an output power of about 500 watts in ultrahigh frequency and 2 designates the anode block which is the outer part of the anode made of oxygen-free copper and extends in a ring form out of the tube. Reference numeral 3 indicates the disc core made of light metals having good thermal conductivity like aluminum or alloy thereof. It has a thickness substantially equal to the height of the anode block 2 and adheres closely to the anode block 2 of the magnetron 1 penetrating through the center hole 4 by soldering or adhesion with a thermal conductive resin. The excitation coil or the permanent magnet 5 and the yoke 6 magnetically coupled thereto compose the magnetic field generator 7 for the magnetron 1. The large number of fins 8, formed of light metal having good thermal conductivity like aluminum or alloy thereof, comprise base parts 8′ fixed by a screw clamp to the outer end part of the core 3 which together with said fins 8 compose the radiator, and the main parts 8″ extending along the axis of the magnetron tube 1 and disposed higher than said magnetic field generator 7 in the outer space of said generator 7. The main parts 8″ of the two fins placed at the two ends of the core are arranged so that the surfaces may face each other at a certain distance as shown in the figure. The main surface of the core 3 has a width sufficient to incorporate said magnetic field generator 7 placed thereon. It has proved preferable that the temperature difference between the circumferential part of the center hole 4 of the core 3 and the outer end part of the core 3 is smaller than about 50° C. in view of the relation between the outer ambient temperature in usage and the maximum allowed temperature of the anode of the magnetron 1.

The weight of the core 3 is about 20 percent—60 percent of the total weight of the cooling means. When an example of a concrete size of the core 3 is given with reference to FIG. 3, m_1 is 133 mm., m_2 is 130 mm., the thickness is 37 mm., the minimum cross-sectional area along the Y—Y′ cross section is 27 cm.^{2}, the maximum area is 48 cm.^{2}, and the weight of the core made of aluminum is about 1.5 kg. The total weight of the two groups of fins made of aluminum whose total surface area is 0.82 m.^{2} is 3.2 kg. The size of m.$_1$ relates to the size of magnetic field generator 7, but must be made larger than about 30 mm.

The device comprising the cooling means having said values exhibits the characteristics shown by the solid line *a* in FIG. 4. The same figure shows the variation of the anode temperature when the repetition of 15 minutes' operation and 15 minutes' rest is made at a room temperature of 25° C. It is understood that this device has a colling ability superior to the one of the forced air-cooling shown by the broken line *b*. It is also understood that the temperature rises gradually so that the device demonstrates an excellent radiative effect when it is applied to a domestic-use microwave range used in such transient characteristic regions.

As has been described hereinabove, the natural air-cooled type cooling means of the device according to this invention are composed of a large number of fins arranged in the outer space of the magnetic field generator and the core for thermally connecting the substrate of the fins to the anode block of the magnetron tube. The size and the heat capacity of said core are made sufficiently large to mount the magnetic field generator thereon. Further, the difference between the temperature around the center hole of the core and the temperature at the outer end part of the core is made less than about 50° C., so that when the anode temperature of the magnetron rises during the operation of the device, the temperature of the outer end part of the core or the substrate of the fins also rises and the heat generated is effectively dissipated into the outer space by the group of fins by natural convection mainly. Further, a large number of fins can be provided to the core and the cooling device substantially covers and mechanically protects the magnetron tube. Thus the device of this invention is particularly effective when used for a domestic-use microwave range having an output power of the order of 500 watts in ultrahigh frequency.

We claim:

1. In an air-cooled magnetron device comprising a magnetron tube and a magnetic field generator magnetically coupled to said magnetron tube, a cooling arrangement comprising a substantially rectangular board having a hole at the center thereof to which the anode block of the magnetron tube is fitted and on which the magnetic field generator is mounted, and a pair of groups of fins attached to the opposite side-faces of said board, said groups of fins being disposed so as to protect said magnetic field generator.

2. A cooling arrangement as defined in claim 1, wherein said fins are disposed in such a manner that the surfaces of said fins are parallel with the main axis of the magnetron tube and with the opposing direction of said pair of groups of fins.

3. A cooling arrangement as defined in claim 1, wherein the weight of said board is 20 percent to 60 percent of the total weight of said cooling arrangement, and the difference between the temperature of the peripheral part of said hole in said board and the temperature of the edge part of said board where said group of fins are attached is less than 50° C. during the operation of said magnetron tube.

4. A cooling arrangement as defined in claim 1, wherein said board and said fins are made of aluminum.

5. A cooling arrangement as defined in claim 1, wherein said board and said fins are made of an alloy of aluminum.