United States Patent [19]

Mashin et al.

[11] **3,774,119**

[45] **Nov. 20, 1973**

[54] **A.C. POWERED DUAL MAGNETRON STRUCTURE FOR INDEPENDENTLY GENERATING TWO FREQUENCIES**

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[22] Filed: **July 19, 1971**

[21] Appl. No.: **163,699**

[52] **U.S. Cl.**..... **331/56,** 315/39.51, 315/39.53, 331/86

[51] **Int. Cl.**..... **H01j 25/50,** H03b 9/10

[58] **Field of Search**..... 331/86, 56; 219/10.55; 315/39.51, 39.53, 39.75

[56] **References Cited**

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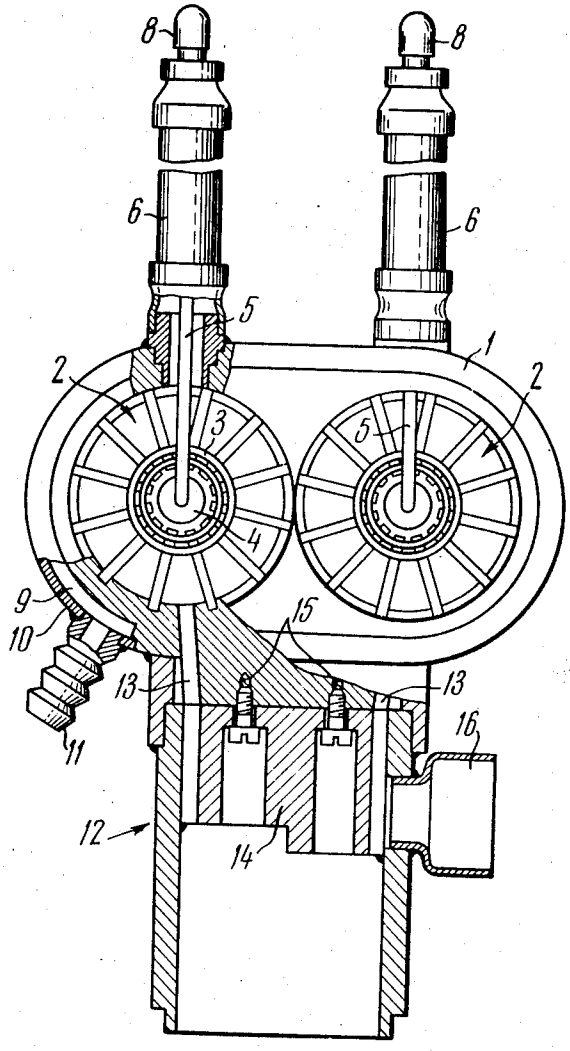
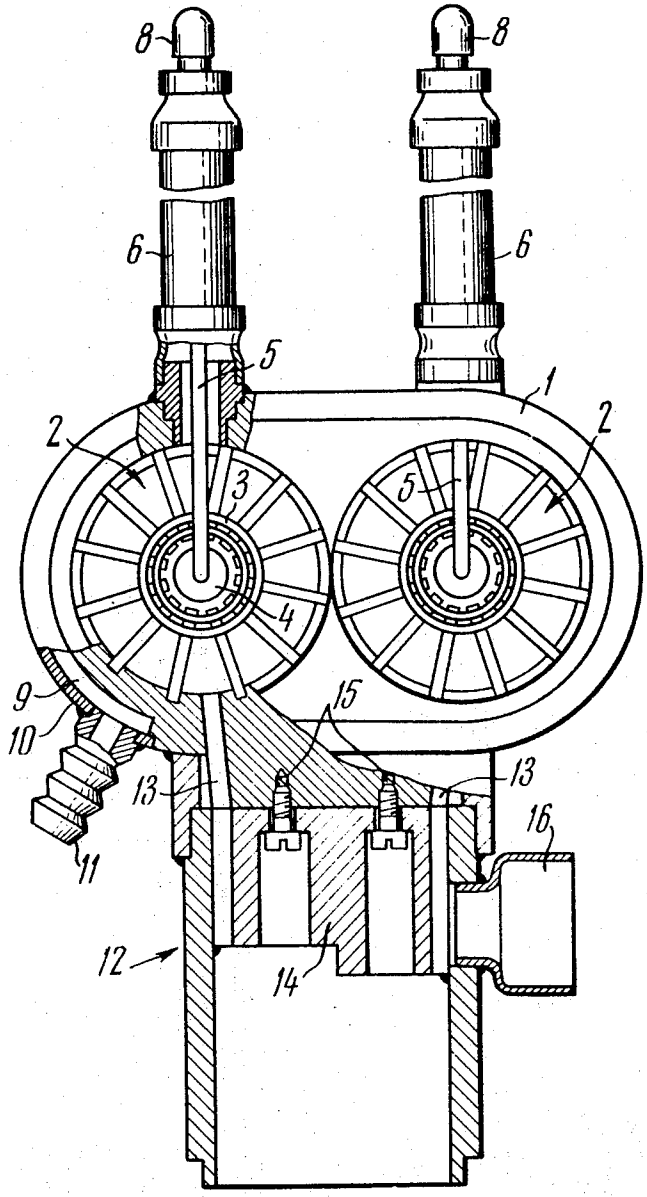
[57] **ABSTRACT**

A microwave oscillator, more specifically, an a.c.-powered magnetron comprising at least two cathodes disposed in spaced parallel relation and having an output arrangement. Two multi-cavity anode blocks together with the cathodes make up two oscillatory systems having independent oscillator resonant frequencies and are arranged so that their axes are parallel. The output arrangement may incorporate a wave guide impedance transformer ensuring independent operation of the two oscillatory systems at their resonant frequencies. The wave guide impedance transformer is expediently located at right angles to a plane containing the axes of the oscillatory systems.

2 Claims, 1 Drawing Figure

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A.C. POWERED DUAL MAGNETRON STRUCTURE FOR INDEPENDENTLY GENERATING TWO FREQUENCIES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to microwave oscillators, and more specifically to magnetrons powered directly from an a.c. source.

2. Description of Prior Art

In the prior art, there is a magnetron powered directly from an a.c. source, comprising a multi-cavity anode structure and two cathodes isolated from each other.

These cathodes are arranged both on the same axis of the magetron, one above the other.

This magnetron however suffers from a number of disadvantages.

One of the disadvantages is a very long interaction space along the axis and, as a consequence, a large magnetic gap.

Another disadvantage is that this prior-art magnetron has one anode because of which it acts as a single oscillatory system irrespective of the number of cathodes provided, and the power output of this magnetron is strongly dependent on the magnitude and phase of the r.f. load. This magnetron generates r.f. voltage at a single frequency, which interferes with a uniform distribution of the r.f. electric field in the r.f. load in many cases.

SUMMARY OF THE INVENTION

An object of the present invention is to avoid these disadvantages.

A particular object of the invention is to provide an a.c.-powered magnetron comprising at least two oscillatory systems each of which has a multi-cavity anode structure and a cathode of its own and an output arrangement such that both oscillatory systems can operate independently into a common r.f. load and the output power depends very little on variations in the magnitude and phase of the r.f. load.

With these objects in view, the present invention resides in that in an a.c.-powered magnetron comprising at least two cathodes and an output arrangement, the cathodes are, according to the invention, placed in central chambers of multi-cavity anode blocks disposed so that their axes are parallel, and the said anode blocks together with said cathodes make up two oscillatory systems operating at different resonant frequencies, while the output arrangement comprises an impedance transformer which ensures independent operation of the two oscillatory systems at their resonant frequencies and is placed at right angles to a plane containing the axes of the oscillatory systems.

It is preferable to couple the oscillatory systems to an r.f. load by a segment of rectangular waveguide and U-shaped coupling slots of the impedance transformer located at opposite broad walls of the waveguide so that the input plane of a coupling slot of each oscillatory system is the short-circuit plane at the frequency of the other oscillatory system.

The magnetron disclosed herein will operate reliably when powered, for example, in a push-pull manner from a transformer the centre tap on the secondary winding of which is earthed either solidly or via the coil of an electromagnet which seats up the operating magnetic field of the magnetron by utilizing the rectified anode current of its oscillatory systems.

For a given length of the waveguide, which is dependent on the resonant frequencies of the two oscillatory systems, the mean output power is practically independent of the magnitude and phase of the r.f. load. This is explained by the fact that the reflected waves in the two osillatory systems are opposite in phase so that a decrease in the power output of one oscillatory system will be made up for by an increase in the power output of the other.

Operation of the magnetron disclosed herein at two resonant frequencies spaced apart within the frequency range used for industrial purposes, for example in the working chamber of a heating apparatus, provides for uniform heating.

With an a.c.-powered magnetron, the microwave spectrum is a quazi-noise type owing to the electron frequency shift. With two quazi-noise spectra, the r.f. voltage will be distributed uniformly without any additional contrivances in practically any working chamber, irrespective of its size and shape.

The magnetron disclosed herein is simple in design and to make, and an oscillator built around this magnetron is simple and reliable in operation.

BRIEF DESCRIPTION OF DRAWINGS

The invention will be more fully understood from the following description of a prefered embodiment when read in conjunction with the accompanying drawing showing a cut-away view of a magnetron.

DESCRIPTION OF PREFERRED EMBODIMENT

Referring to the drawing, a magnetron comprises an anode block **1** incorporating two oscillatory systems **2** the anodes of which may, for example, be of laminated construction, with double two-sided straps **3.**

The cathodes **4** are held in place by cross-arms **5** and ceramic cylinders **6.** High voltage supply is fed to the cathodes **4** by means of posts **8** into which the cross-arms **5** are brazed.

The anode block structure **1** is cooled by water admitted into cooling ducts **9** milled in the anode block and hermetically sealed by a jacket **10.**

Cooling water enters and leaves the magnetron by connections **11.**

The oscillatory systems **2** of the magnetron are coupled to an output arrangement **12** which comprises two U-shaped coupling slots **13** of an impedance transformer and a block **14** fastened to the envelope of the anode block **1** by screws **15** and brazing. The magnetron is exhausted through an exhaust tube **16.** The vacuum seal of the output arrangement is not shown in the drawing.

So that the magnetron disclosed herein can give stable operation, it is important that one oscillatory system should not affect the other. To satisfy this requirement, it is necessary that the input plane of the coupling slot (on the waveguide side) of an adjacent section should be a short-circuit plane at the frequency of that oscillatory system which operates during a given half-cycle of the anode voltage. The electrical length of the coupling slots should be chosen such that the length of the side arms of the output arrangement, treated an an E-plane tee, with the resonant cavities connected to them, will accommodate a whole number of half-wavelengths at the frequencies of the adjacent cavities.

In this case, any effect of one oscillatory system on the other will be completely eliminated, even though they may be oscillating simultaneously, which may, for example, occur for some time if the electromagnet placed in the anode circuit of the magnetron has a high inductance or when the magnetron is powered from a d.c. anode supply.

What is claimed is:

1. A magnetron apparatus for producing high-frequency electrical output, comprising: at least two cathodes disposed with their axes in spaced parallel relationship, and an output arrangement; an anode means including anode blocks each of which is disposed to surround each of said cathodes forming an oscillatory system therewith, a plurality of oscillatory systems so formed by said cathodes operating at different inherent resonant frequencies, said output arrangement having wave guide means to feed said different inherent resonant frequencies into a common high-frequency load and an impedance transformer, said transformer being disposed at right angles to a plane containing said axes, which are the axes of the oscillatory systems, thereby ensuring independent and stable operation of said oscillatory systems.

2. A magnetron as of claim 1, in which said oscillator systems are two in number, and wherein said wave guide means comprises a rectangular wave guide duct having opposite walls of the wave guide and said impedance transformer is comprised of U-shaped coupling slots located at the opposite walls of the wave guide so that an input plane of the coupling slot in each one of two said oscillatory systems forms a short-circuit plane at the resonant frequency of the other oscillatory system.

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