Aug. 25, 1959 H. SIXSMITH 2,901,666

MAGNETRON OSCILLATORS

Original Filed Dec. 26, 1951 2 Sheets-Sheet 1

FIG. 1

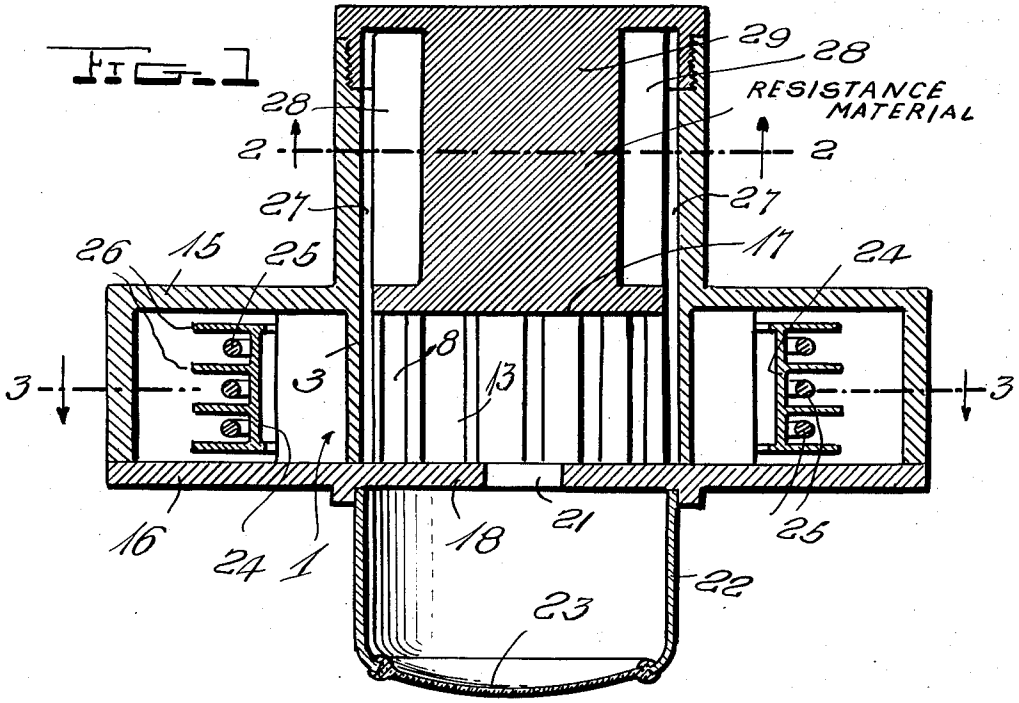

FIG. 2

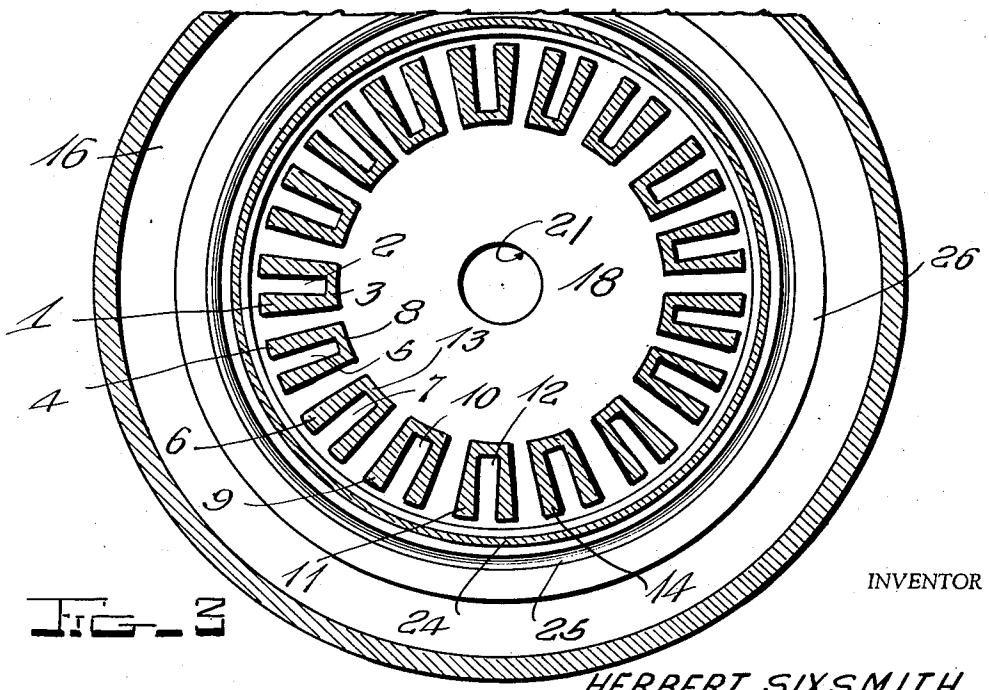

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FIG. 4

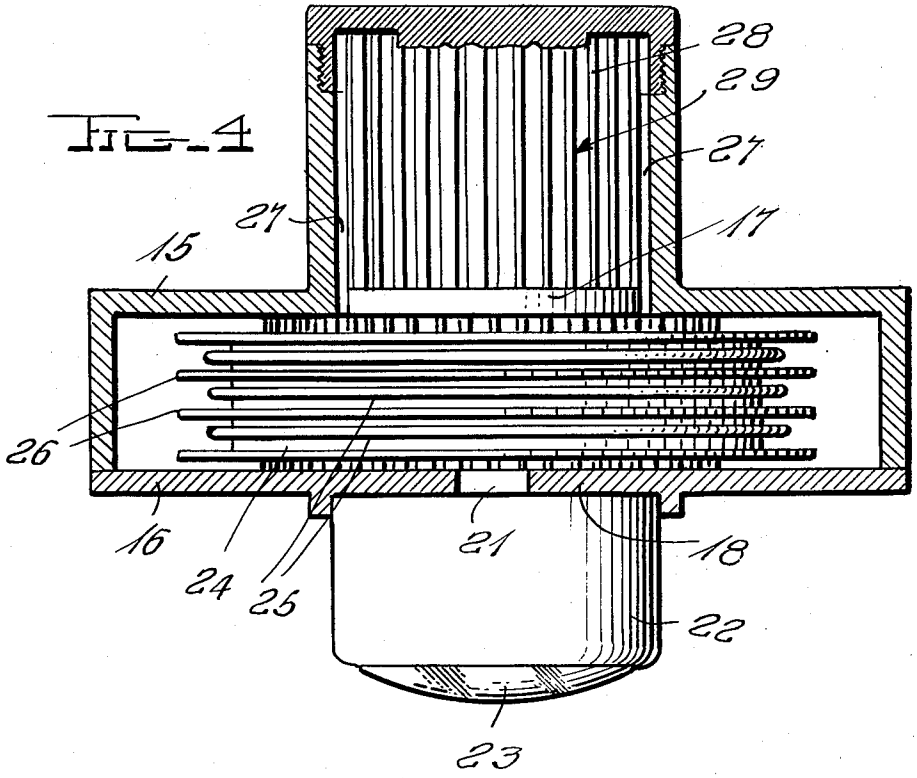
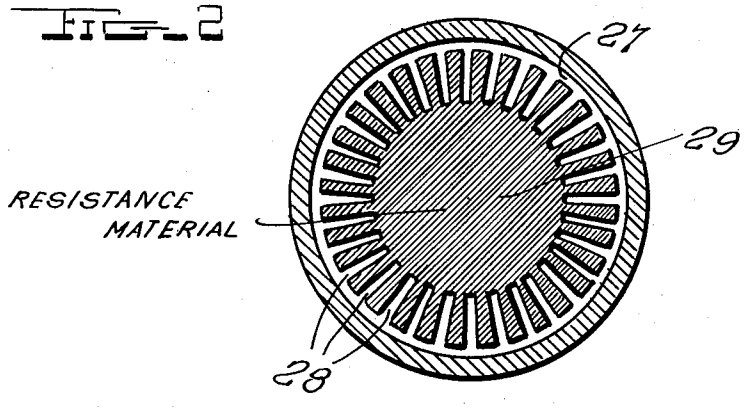


FIG. 2



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2,901,666

MAGNETRON OSCILLATORS

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Original application December 26, 1951, Serial No. 263,280, now Patent No. 2,815,469, dated December 3, 1957. Divided and this application July 29, 1957, Serial No. 674,675

Claims priority, application Great Britain January 8, 1951

4 Claims. (Cl. 315—39.51)

This invention relates to magnetron oscillators and more specifically to magnetron oscillators wherein the anode system is surrounded by a co-axial cathode. Such an arrangement in which the cathode is outside the anode system has, as is well known, the advantage over the at present more usual arrangement in which the cathode is axially within the anode system, in that the cathode surface is greatly increased for a magnetron of given overall dimensions and therefore, for a given type of cathode and a given operating temperature, a larger power is available. Hitherto, however, magnetrons with their cathodes outside their anode systems have not achieved much practical favor because the constructions hitherto proposed have not been very efficient from the oscillatory point of view and have, moreover, not been easy to tune accurately. The present invention seeks to provide improved magnetrons with their cathodes surrounding their anode systems which shall be more efficient as oscillators and more readily tuned than those hitherto proposed.

This application is a division of my application Serial Number 263,280, filed December 26, 1951, now Patent 2,815,469, dated December 3, 1957, for Magnetron Oscillators.

According to this invention a magnetron oscillator comprises an outer cathode co-axially surrounding an anode system consisting of a ring of cavity resonator anodes and in turn co-axially surrounding a central cavity resonator, coupling being provided to the central cavity by spaces between anode segments in the anode system and means being provided for taking output energy from the central cavity.

Preferably the central cavity resonator is of the H_{011} type and the mode of oscillation is the π mode which excites an H_{011} standing wave in the central cavity. Preferably also undesired higher modes of oscillation are suppressed by means providing coupling to resistive loading means and so arranged as to be as nearly as possible uncoupled as respects the desired π mode.

One of the objects of my invention is to provide a magnetron oscillator which includes damping means for suppressing undesired higher modes of oscillation where the damping means comprises an annular coupling slot and resistive loading means coupled thereby.

The invention will be more clearly understood from the specification hereinafter following by reference to the accompanying drawings, in which:

Fig. 1 is a vertical sectional view through a magnetron embodying the principles of my invention;

Fig. 2 is a transverse sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is a transverse sectional view on line 3—3 of Fig. 1; and

Fig. 4 is an elevational view of the magnetron assembly showing particularly the resistive loading means.

Referring to the drawings, there is provided a ring

or cylinder of anode segments **1, 4, 6, 9, 11, 14** . . . integrally supported at their ends by means of end discs **15** and **16**. The inner surfaces **3, 8, 13** . . . of the anode segments lie on the curved surface of an imaginary cylinder, this cylindrical surface constituting the curved surface of a central H_{011} cavity resonator, the ends of which are defined by end surfaces **17** and **18**. The spaces **2, 5, 7, 10, 12** . . . between the anode segments constitute cavity resonators and the segments **1** and **4, 6** and **9, 11** and **14** . . . are connected in pairs as shown at their inner ends so as to provide uncoupled cavity resonators **2, 7, 12** . . . There are no connections between the anode segment pairs **4** and **6, 9** and **11** . . . so that the cavity resonators **5, 10** . . . couple directly into the centrally disposed cavity resonator. A thermionic cathode **24** activated on its inner surface with suitable emissive material co-axially surrounds the anode system. The cathode **24** is provide with heaters **25** and may be also provided as shown with radiator fins **26** for cooling purposes.

Useful power output is taken from the central cavity in any convenient way e.g. by means of a wave guide output such as the H_{011} wave guide output system shown in Fig. 1. This system comprises an iris **21** which may be adjustable, a circular wave guide **22** and a window **23**.

The desired mode of oscillation for this magnetron is the π mode in which alternate anode segments oscillate in opposite phase so that the oscillatory currents flowing along the inner surfaces **2, 8, 13** . . . are all in the same phase. That is the condition required for excitation of an H_{011} standing wave in the control cavity. There are, however, possibilities of other modes of oscillation exciting more complicated wave patterns in the central cavity e.g. the H_{111}, H_{211}, and H_{311} modes. However each of these wave patterns has an axial component of electric field and this fact is taken advantage of in carrying out the present invention by damping out oscillations at these undesired more complicated modes.

In the illustrated embodiment this is done by means of an annular coupling slot **27** and a resistance load which may consist of a number of radial slots **28** cut in a cylinder **29** of resistance material. The annular slot **27** provides finite coupling of the higher modes of oscillation to the resistance load while the coupling of the H_{011} mode is theoretically zero and can in practice be made negligibly small.

The magnetron above described and illustrated may be mechanically tuned quite simply—for example by fitting a plunger or disc (not shown) which is adjustable in an axial direction across the central cavity. Electronic tuning may be effected by projecting one or more clouds of electron space charge into the central cavity; that is to say by projecting one or more beams or clouds of electrons into said cavity.

While I have described my invention in certain of its preferred embodiments, I realize that modifications may be made and I desire that it be understood that no limitations upon my invention are intended other than may be imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. A magnetron oscillator comprising an anode structure and a cathode spaced from the anode structure to constitute a cathode-anode space, said anode structure comprising a plurality of discrete anode members each of said members comprising a pair of limbs that are disposed substantially parallel to and spaced from each other and joined at their ends by a third limb that surrounds a cylindrical space, each of said pairs of anode limbs enclosing a longitudinal cavity resonator, upper

and lower portions connected to opposite ends of said pairs of anode limbs closing said cylindrical space constituting said cylindrical space a cylindrical cavity resonator, said cathode comprising a cylindrical cathode disposed coaxially with and surrounding and spaced from said anode structure and having a cylindrical activated surface facing said anode structure, couplings between the cathode anode space and said cylindrical cavity resonator, said couplings comprising the spaces between said pairs of anode members, and out-coupling means coupled to said cylindrical cavity resonator for extracting oscillatory energy therefrom, and damping means for suppressing undesired higher modes of oscillation, said damping means comprising an annular coupling slot and resistive loading means coupled thereby.

2. A magnetron oscillator comprising an anode structure and a cathode spaced from the anode structure to constitute a cathode-anode space, said anode structure comprising a plurality of discrete pairs of anode members disposed substantially parallel to and spaced from each other and surrounding a cylindrical space, each pair of anode members enclosing a longitudinal cavity resonator, upper and lower portions connected to opposite ends of said anode members closing said cylindrical space constituting said cylindrical space, a cylindrical cavity resonator of the H_{011} type, said cathode comprising a cylindrical cathode disposed coaxially with and surrounding and spaced from said anode structure and having a cylindrical activated surface facing said anode structure, couplings between the cathode space and said cylindrical cavity resonator, said couplings comprising the spaces between said anode members, and out-coupling means coupled to said cylindrical cavity resonator for extracting oscillatory energy therefrom, and damping means for suppressing undesired higher modes of oscillation, said damping means comprising an annular coupling slot and resistive loading means coupled thereby.

3. A magnetron oscillator as set forth in claim 1 in which said resistive loading means is constituted by a radially slotted resistance member.

4. A magnetron oscillator as set forth in claim 2 in which said resistive means is constituted by a radially slotted resistance member.

References Cited in the file of this patent

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