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MAGNETRON OSCILLATORS

2,815,469

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2 Sheets-Sheet 1

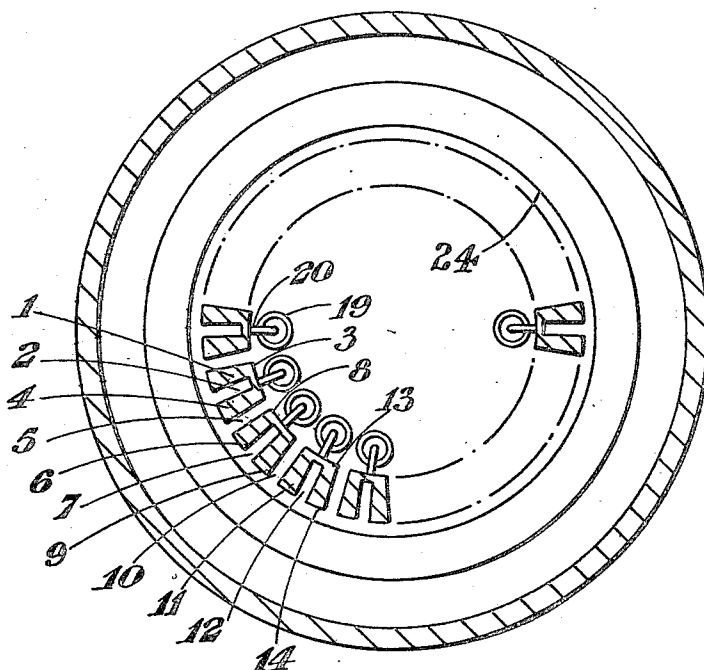


Fig. 1.

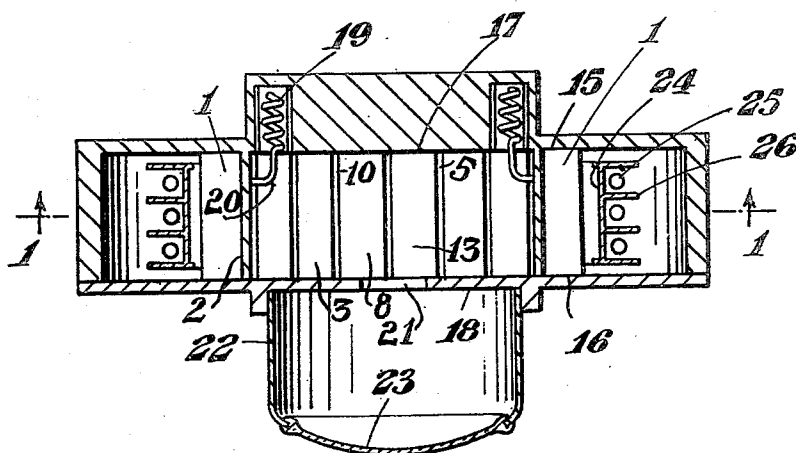


Fig. 2.

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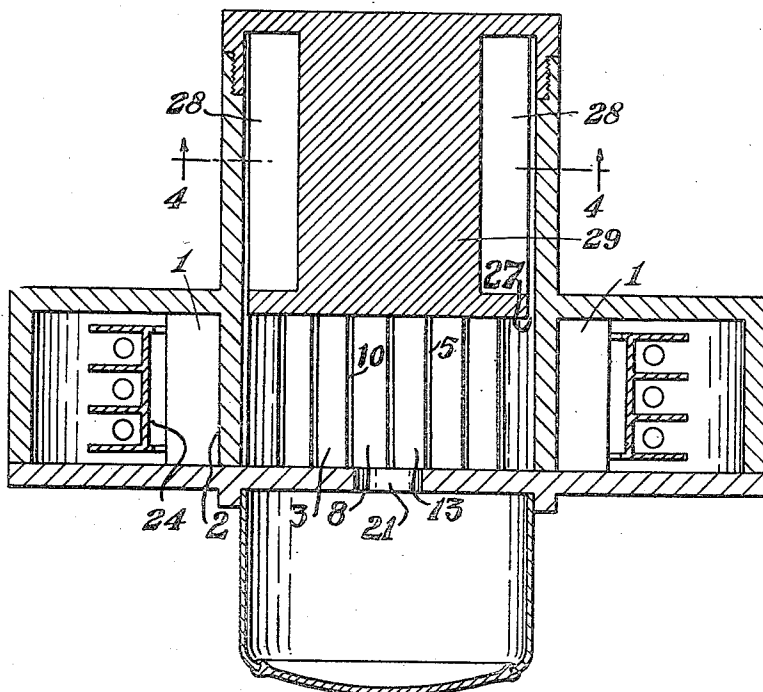


FIG. 3.

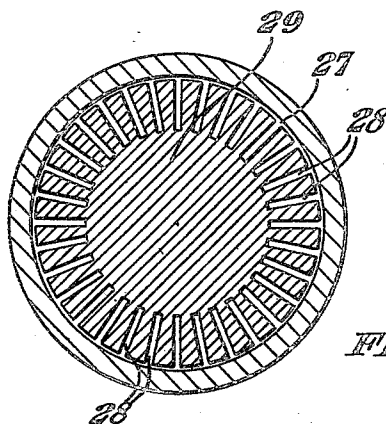


FIG. 4.

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MAGNETRON OSCILLATORS

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6 Claims. (Cl. 315—39.77)

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.

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.

Output energy may be taken from the central cavity by means of a loop and a concentric line or by means of an output wave guide.

The invention is illustrated in the accompanying drawings in which Figures 1 and 2 show one embodiment, Fig. 1, being a schematic section showing the nature of the electrode arrangement employed and Fig. 2 being a similar section through the axis of the magnetron, Fig. 1 being taken at right angles to the axis along the line 1—1 of Fig. 2, while Figs. 3 and 4 illustrate a modification, Fig. 3 being a simplified section through the axis of the magnetron and Fig. 4 being a section at right angles to the axis and taken along the line 4—4 of Fig. 3.

Referring to Figs. 1 and 2 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

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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 provided 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 loop and concentric line output or by means of a wave guide output such as the H_{011} wave guide output system shown in Fig. 2. 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. This is the condition required for excitation of an H_{011} standing wave in the central 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 a loop or loops 20 lying in a plane or planes passing through the axis of the central cavity and providing coupling to a resistive load or loads 19. The loop or loops so positioned have theoretically zero coupling so far as the H_{011} wave is concerned. In practice the coupling for this wave may be made very small indeed so that the said loop or loops and their associated resistance or resistances have virtually no damping effect as regards the desired π mode.

In the modification shown in Figs. 3 and 4, the loops 20 and resistive loads 19 of Figs. 1 and 2 for damping out undesired modes are replaced by 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 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 magnetrons 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.

I claim:

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 anode members disposed 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 members attached to opposite ends of said pairs of anode members closing said cylindrical space constituting said cylindrical space, a cylindrical cavity resonator, said

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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.

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 pairs of anode members disposed 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 members attached 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.

3. An oscillator as claimed in claim 1 and comprising damping means for suppressing undesired higher modes of oscillation said damping means comprising resistive loading means external of said cylindrical cavity resonator and coupling means coupling said cylindrical cavity resonator to said resistive loading means therefor said coupling means being substantially uncoupled as respects the π mode.

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4. An oscillator as claimed in claim 2 and comprising damping means for suppressing undesired higher modes of oscillation said damping means comprising resistive loading means external of said cylindrical cavity resonator and coupling means coupling said cylindrical cavity resonator to said resistive loading means therefor said coupling means being substantially uncoupled as respects the π mode.

5. An oscillator as claimed in claim 1 and comprising damping means for suppressing undesired higher modes of oscillation said damping means comprising resistive loading means and coupling means therefor said coupling means being substantially uncoupled as respects the π mode, and comprising a loop lying in a plane passing through the axis of the central cavity and providing coupling to said resistive loading means.

6. An oscillator as claimed in claim 2 and comprising damping means for suppressing undesired higher modes of oscillation said damping means comprising resistive loading means and coupling means therefor said coupling means being substantially uncoupled as respects the π mode, and comprising a loop lying in a plane passing through the axis of the central cavity and providing coupling to said resistive loading means.

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