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MAGNETRON

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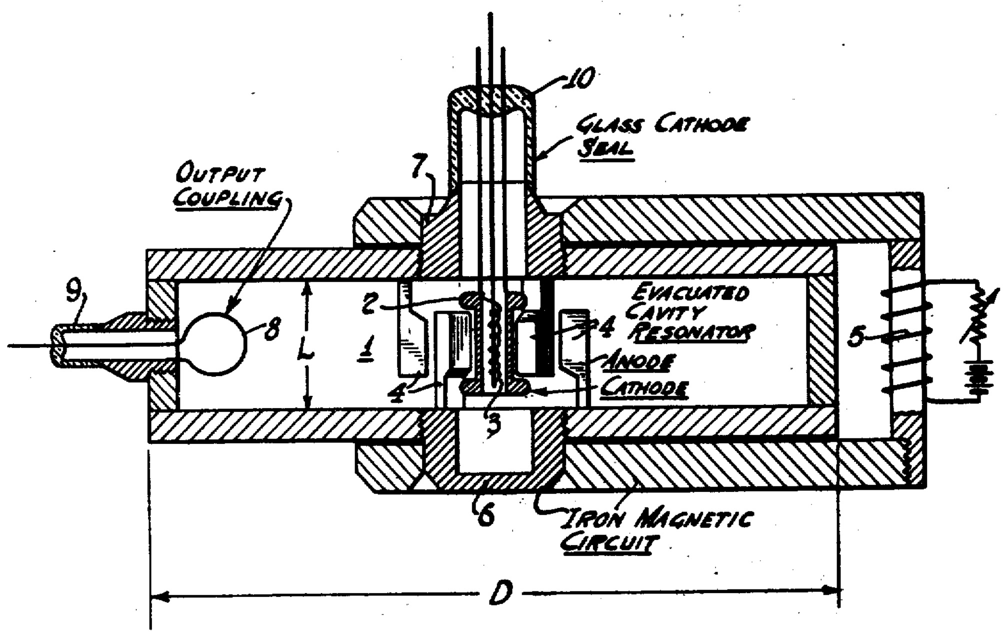

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2,424,886

UNITED STATES PATENT OFFICE

2,424,886

MAGNETRON

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12 Claims. (Cl. 250—27.5)

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This invention concerns an improved type of magnetron construction.

A difficulty experienced in using electron discharge device magnetrons of the multi-segment anode structure type in pulse echo obstacle detection systems, has been caused by the presence of spurious oscillations. These spurious oscillations exit during the short interval in which the magneton is excited to produce a pulse of ultra high frequency oscillations, as a result of which the intensity of output energy is spread out over a plurality of frequencies instead of being concentrated on the desired frequency of oscillation. It has also been observed that as a result of these undesired modes of oscillation, there is a tendency on the part of the magnetron to jump from one operating frequency to another when there is a substantial change in input potential. Thus, when the anode-to-cathode potential is applied to the magnetron in extremely short pulses, as in military radio locater systems, more than one pulse may result in quick succession and the radio frequency output power will be modulated downward at the moment of transition from one mode to the other. In order to prevent or discourage some of the undesired modes of oscillation, it has been proposed, with some success, to "strap" the magnetrons; that is, to add connections between anode segments so as to spoil the resonance characteristic at some of the undesired resonant frequencies or to spoil the oscillation by distributing the natural phase relations to thereby increase electronic and other losses at the undesired frequencies.

Reference is made to my United States Patent 2,217,745 which generally describes the type of magnetron referred to above which, with improvements, is now customarily employed in pulse echo obstacle detection systems.

An object of the present invention is to provide a magnetron oscillator of the multi-segment anode structure type which oscillates at a single desired resonant frequency within the frequency range of interest. It should be understood at this time that although the magnetron of the present invention confines the multi-segment anode structure to resonating at a single desired frequency, there may be present utterly different modes of oscillation far outside the frequency range of interest and which can be ignored.

Another object is to simplify the construction, to reduce the cost of manufacture and to improve the conversion efficiency of a magnetron oscillator.

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In the magnetrons now commonly used in the art, each anode segment is on a separate support so that, in effect, each anode and its support is a separate tuned circuit. All these separate circuits, coupled together, form the equivalent of an artificial transmission line shorted on itself. Such a structure has a series of resonant frequencies all close together and not far removed from the resonant frequency of each anode and support taken alone. Only one of these modes causes equal amplitude of oscillation of all anodes and 180° phase relation between oscillations of adjacent anodes. The present invention limits the operation to this one most desirable mode.

The following is a detailed description of the improved magnetron oscillator of the invention, in conjunction with a drawing whose single figure illustrates in cross-section the essential details of the improved magnetron construction.

Referring to the drawing, there is shown an electron discharge device magnetron comprising an evacuated cavity resonator 1, a hollow cathode 2 in the center of the cavity resonator heated by an interiorly located thermionic filament 3, and an anode structure consisting of an even number of short length identical anode segments 4. A coil 5 associated with iron pole pieces 6 and 7 produces a magnetic field whose flux lines extend parallel to the cathode.

An important feature of the present invention lies in the dimensional construction of the cavity resonator whose length L is made to be relatively short compared to the diameter D of the resonator. Alternately located anode segments are directly connected together and to the same face of the cavity resonator, while adjacent anode segments are connected to opposite faces of the cavity resonator.

Ultra high frequency oscillations are taken out of the magnetron by means of an output coupling loop 8 which is coupled to utilization apparatus, such as a transmission line leading to an antenna, not shown. One end of the loop 8 is shown coupled to one wall of the cavity resonator, while the other end extends externally through a glass seal 9. The cathode heater leads and the cathode lead extend out from the magnetron through glass seal 10. The heater 3 may be embedded in high temperature insulating material inside hollow cathode 2 after the usual manner of constructing indirectly heated cathodes. The central outside surface of cathode 2 may be oxide coated according to common practice. The ends of the cathode 2 are provided with flanges which act as shields to help confine electrons to the central portion of the device.

The anode segments 4 may be any even number of segments, preferably six or eight, and lie in a circle around the cathode. Those portions of these anode segments upon which the electrons impinge are thicker than the short stubs which connect these segments to the oppositely disposed faces of the resonator, as shown.

In view of the fact that the length L of the cavity resonator is short, there is a correspondingly short magnetic path which requires smaller magnetizing force than some conventional magnetrons. The required magnetizing force for the magnetron of the invention can be obtained by a small electromagnet or by means of permanent magnets.

The short cathode and heater leads, as well as the short supports for the anode segments, make for a simpler mechanical construction than prior structures. The reduced magnetic field requirements and short cathode supports also make for a lighter and more compact magnetron transmitter assembly than conventional magnetrons.

The magnetron of the invention is characterized by the absence of spurious modes of oscillation in the frequency region near the resonant frequency of the cavity resonator, mainly because all anode segments are forced to have the same amplitude of oscillation, and all alternate anode segments are constrained to operate with equal phase.

The resonant frequency of the oscillator is determined primarily by the dimensions of the cavity resonator modified somewhat toward a smaller diameter by the effect of the capacity formed by the electrodes. This cavity resonator may either by cylindrical or rectangular in form but a cylindrical form is preferred because it is easier to construct and is a better mechanical structure.

Where exact adjustment of frequency, apart from the adjustment made by choice of dimensions during manufacture, is required, I may add internal means operable through a flexible diaphragm or metal bellows for modifying the electromagnetic field distribution to change the frequency. For many purposes no adjustment other than that obtained by determining dimensions during manufacture is required.

What is claimed is:

1. A magnetron comprising a cavity resonator having a cathode in the interior thereof positioned at right angles to two parallel surfaces defining the shortest dimension of said resonator, an anode structure surrounding said cathode and composed of a multiplicity of equal length anode segments greater than two located between said surfaces and mounted with alternate segments on the same surface and adjacent segments on opposite ones of said two surfaces of said cavity resonator, and means adjacent said resonator for producing a magnetic field having flux lines extending in a direction substantially parallel to said cathode.

2. A magnetron comprising a cylindrical cavity resonator whose length is short relative to its diameter, a cathode within said resonator, and an anode structure surrounding said cathode, said anode structure being composed of an even number of equal length anode segments greater than two located between those surfaces of said resonator which define the boundaries of said length and mounted in the interior with alternate segments on opposite faces of said cavity resonator, and means adjacent said resonator for producing a magnetic field.

3. A magnetron comprising a cylindrical cavity resonator whose length is short relative to its diameter, a cathode in the center and positioned along the length of said cavity resonator, and an anode structure surrounding said cathode and which is composed of a plurality of identically dimensioned anode segments greater than two mounted in the interior, alternate segments being mounted on opposite faces of said cavity resonator, and means adjacent said resonator for producing a magnetic field having flux lines extending in a direction substantially parallel to said cathode.

4. A magnetron comprising a cavity resonator whose length is short relative to its transverse dimensions, a cathode in the interior and positioned along the length of said cavity resonator and located between opposite faces thereof, and an anode structure surrounding said cathode and composed of an even numbered multiplicity of equal dimensioned anode segments greater than two, alternate segments being directly connected to the same face and adjacent segments being connected to opposite faces of the resonator, and magnetic pole pieces at opposite ends of said cathode for producing a magnetic field.

5. An eelctron discharge device comprising an evacuated cavity resonator having a short dimension and a long dimension, a cathode in its interior and an anode structure coaxial with said cathode, said resonator having two substantially parallel surfaces defining said short dimension, said cathode and anode being positioned between said two surfaces, said anode comprising a multiplicity of identically dimensioned anode segments greater than two mounted with alternate segments on the same side and adjacent segments on opposite sides of said cavity resonator.

6. An electron discharge device oscillator comprising a cavity resonator whose length is short compared to its diameter, a cathode and an anode structure in the interior of said resonator, said anode structure comprising an even numbered plurality of identically dimensioned anode segments greater than two and arranged in a circle and mounted on and located between those opposite faces of said resonator which define the bounds of said short dimension, adjacent segments being mounted on different faces of said resonator by short metallic supports.

7. An electron discharge device oscillator comprising a cavity resonator whose length is short compared to its diameter, a cathode and an anode structure in the interior of said resonator, said anode structure comprising an even numbered plurality of equal length anode segments greater than two and arranged in a circle and mounted on those opposite faces of said resonator which define the bounds of said short dimension, adjacent segments being mounted on different faces of said resonator by short metallic supports, those portions of the anode segments upon which the electrons impinge extending closer to the cathode and having greater surface area than said metallic supports linking said segments to the opposite faces of said resonator, and means adjacent said resonator for applying a magnetic field substantially parallel to said short dimension.

8. An electron discharge device oscillator comprising a cavity resonator whose length is short compared to its diameter, a cathode and an anode structure in the interior of said resonator, said anode structure comprising an even num-

bered plurality of equal length anode segments greater than two and arranged in a circle and mounted on those opposite faces of said resonator which define the bounds of said short dimension, adjacent segments being mounted on different faces of said resonator by short metallic supports, those portions of the anode segments upon which the electrons impinge extending closer to the cathode and having greater surface area than said metallic supports linking said segments to the opposite faces of said resonator, and means for applying a magnetic field substantially parallel to said short dimension, said means including a yoke of electromagnetic material having opposite pole pieces positioned adjacent said opposite faces of said resonator.

9. A magnetron comprising a cavity resonator having two substantially parallel flat surfaces, a cathode in the interior of said resonator at right angles to said flat surfaces, and an anode structure surrounding said cathode and coaxial therewith, said anode structure having a multiplicity of identically dimensioned anode segments greater than two mounted with alternate segments on the same surface and adjacent segments on different ones of said two flat surfaces, said cathode including a hollow electron emitting element having a heater therein, and shields at the ends of said cathode for confining the electrons emitted by said cathode.

10. An electron discharge device oscillator comprising a cavity resonator whose length is short compared to its diameter, a cathode and an anode structure in the interior of said resonator, said anode structure comprising a plurality of equal length anode segments greater than two and arranged in a circle and mounted on those opposite faces of said resonator which define the bounds of said short dimension, adjacent segments being mounted on different faces of said resonator by short metallic supports, those portions of the anode segments upon whch the electrons impinge extending closer to the cathode and having greater surface area than said metallic

supports linking said segments to the opposite faces of said resonator, and means located externally of said resonator for applying a magnetic field substantially parallel to said short dimension.

11. A magnetron comprising a cavity resonator having a pair of flat surfaces defining its shortest dimension, a cathode and an anode structure in the interior of said resonator and located between said flat surfaces, said anode structure being composed of a plurality of equal dimensioned anode segments greater than two, alternate segments being directly connected to the same surface and adjacent segments being directly connected to the opposite surfaces of the resonator, and means located externally of said resonator for producing a magnetic field with flux lines parallel to said cathode.

12. An electron discharge device comprising a cavity resonator having a pair of flat surfaces defining its shortest dimension, a cathode and an anode in the interior of said resonator and located between said flat surfaces, said anode structure being composed of a plurality of equal dimensioned anode segments greater than two, alternate segments being directly connected to the same surface and adjacent segments being directly connected to opposite surfaces of the resonator.

CLARENCE W. HANSELL.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,154,758	Dallenbach	Apr. 18, 1939
2,167,201	Dallenbach	July 25, 1939
2,128,237	Dallenbach	Aug. 30, 1938

FOREIGN PATENTS

Number	Country	Date
449,920	Great Britain	July 7, 1936

Disclaimer

2,424,886.—*Clarence W. Hansell*, Port Jefferson, N. Y. MAGNETRON. Patent dated July 29, 1947. Disclaimer filed Sept. 13, 1949, by the assignee, *Radio Corporation of America*.

Hereby enters this disclaimer to claims 1 to 6 inclusive, 9, 11, and 12 of said patent.

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bered plurality of equal length anode segments greater than two and arranged in a circle and mounted on those opposite faces of said resonator which define the bounds of said short dimension, adjacent segments being mounted on different faces of said resonator by short metallic supports, those portions of the anode segments upon which the electrons impinge extending closer to the cathode and having greater surface area than said metallic supports linking said segments to the opposite faces of said resonator, and means for applying a magnetic field substantially parallel to said short dimension, said means including a yoke of electromagnetic material having opposite pole pieces positioned adjacent said opposite faces of said resonator.

9. A magnetron comprising a cavity resonator having two substantially parallel flat surfaces, a cathode in the interior of said resonator at right angles to said flat surfaces, and an anode structure surrounding said cathode and coaxial therewith, said anode structure having a multiplicity of identically dimensioned anode segments greater than two mounted with alternate segments on the same surface and adjacent segments on different ones of said two flat surfaces, said cathode including a hollow electron emitting element having a heater therein, and shields at the ends of said cathode for confining the electrons emitted by said cathode.

10. An electron discharge device oscillator comprising a cavity resonator whose length is short compared to its diameter, a cathode and an anode structure in the interior of said resonator, said anode structure comprising a plurality of equal length anode segments greater than two and arranged in a circle and mounted on those opposite faces of said resonator which define the bounds of said short dimension, adjacent segments being mounted on different faces of said resonator by short metallic supports, those portions of the anode segments upon whch the electrons impinge extending closer to the cathode and having greater surface area than said metallic

supports linking said segments to the opposite faces of said resonator, and means located externally of said resonator for applying a magnetic field substantially parallel to said short dimension.

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