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OUTPUT CONNECTION FOR MAGNETRON

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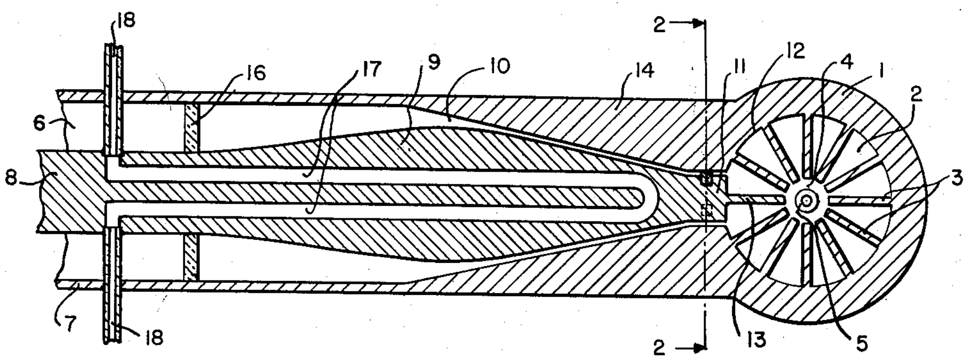

FIG. 1

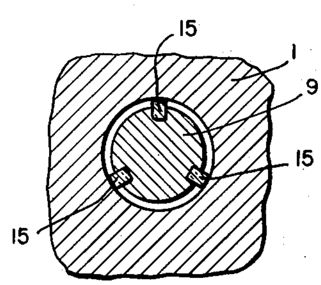

FIG. 2

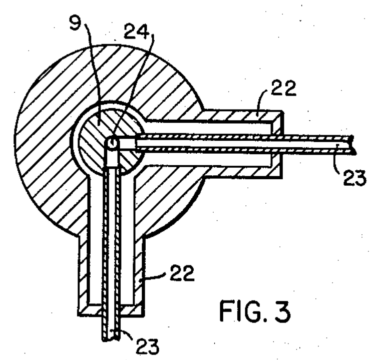

FIG. 3

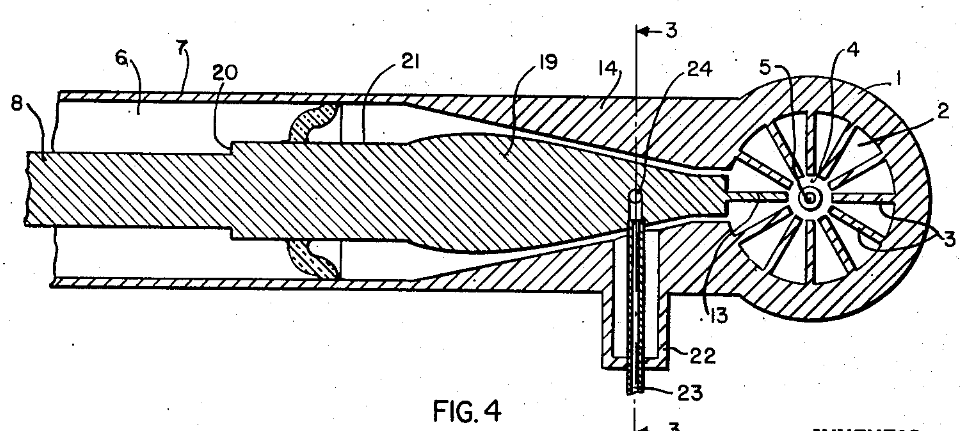

FIG. 4

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OUTPUT CONNECTION FOR MAGNETRON

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6 Claims. (Cl. 315—39)

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This invention relates to a system for extracting power from magnetrons and particularly to such a system which is capable of functioning efficiently over a wide band of frequencies.

In applying magnetrons to the many and varied uses requiring microwave power, a large number of types have been developed each of which is usually adapted to perform with satisfactory efficiency when used in connection with a certain type of load, under certain ambient conditions or by reason of some other practical circumstance. The present invention departs from this general pattern of adaptability in that it provides for extracting power from the magnetron with high efficiency over a wide band of frequencies, and moreover it is capable of extracting relatively large amounts of power.

The invention provides a magnetron capable of application to many uses requiring a varied range of frequencies. Such a magnetron is valuable in laboratory experimental work where it may be applied to a wide variety of uses requiring adjustability over wide ranges of frequencies.

The invention employs what may be termed a current coupling function as an output power conducting means rather than an inductive coupling such as takes place in looped type output coupling means. Power is extracted from the magnetron in the present invention by utilizing a structure which involves a minimum of change in the geometrical symmetry of the resonator elements of the magnetron. Such a structure results in efficient overall operation of the magnetron and provides for incorporating an efficient broad band means for conducting power therefrom to a coaxial transmission line. A suitable mechanism (not shown) is provided for tuning the magnetron throughout the desired range of frequencies.

The invention is herein described in connection with a magnetron having a resonator system the cavities of which are separated by a plurality of vanes or segments. The general aspects of the resonator structure, the cathode and a source of the applied magnetic field may be conventional. The novel features reside in the manner of extracting power from the resonator system. To do this one of the vanes or segments in the resonator is isolated mechanically and electrically from the other segments and the wall structure of the magnetron anode. This isolated segment desirably has the same dimensions and relative disposition within the resonator as the other segments. It is supported and desirably made integral with an extension of the inner

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conductor of the coaxial line into which the power from the magnetron is fed.

A short portion of the coaxial line adjacent to the magnetron contains the output elements and will be described as the output system of the magnetron. The inner conductor of this output system is supported within a conical chamber formed in the outer member thereof. The outer member opens into the resonator chamber of the magnetron and both members are designed to present a desired pattern of impedance change extending from the magnetron to the coaxial transmission line.

The output system is constructed to present a relatively low impedance at its inner end and a gradually increasing impedance as it extends outwardly to the point where it joins the coaxial transmission line. The manner of varying the impedance will be more fully described hereinafter.

It is an object of the present invention to provide means for increasing the scope of usefulness of a magnetron.

A further object of the invention is to provide a magnetron which is both functionally and structurally efficient.

A still further object of the invention is to provide a magnetron having an output connection capable of extracting power from the magnetron with relatively high efficiency over a wide band of frequencies.

A still further object of the invention is to provide a magnetron having a structure which may be fabricated by following relatively simple techniques.

A still further object of the invention is to provide a magnetron having the characteristics above mentioned together with the ability to produce relatively large amounts of power.

Other objects and features of the invention will more fully appear from the following description and will be particularly pointed out in the accompanying claims.

To present a better understanding of the invention particular embodiments thereof will be described and illustrated in the drawings in which:

Fig. 1 is a cross-sectional view taken at right angles to the axis of the cathode thereof.

Fig. 2 is a cross-section taken on line 2—2 of Fig. 1.

Fig. 3 is a cross-section taken on line 3—3 Fig. 4.

Fig. 4 is a cross-sectional view similar to Fig.

1 showing a modification of the structure shown therein.

As above pointed out, certain parts of the magnetron may be of conventional design. For example, the anode structure is of the well known cavity resonator type in which the anode 1 encloses a large portion of the evacuated envelope of the magnetron. The resonating system is formed by a plurality of resonator chambers 2 formed in the anode block 1 and which collectively constitute the main resonating space of the magnetron. The chambers are separated from one another by a plurality of vanes or segments 3 which are arranged radially and whose inner ends define the central space 4 within which is received a cathode 5 which is or may be of conventional construction.

The device is energized in the usual way and is provided with a source of magnetic flux, not shown, applied axially of the cathode thereby providing for generating high frequency power.

The invention resides in the means employed for extracting power from the device. To do this the anode block 1 is extended radially to embrace a power output system which is directly connected to a coaxial transmission line 6. This extension of the anode constitutes the outer member of the output system and is coupled to the outer member 7 of the coaxial transmission line.

The inner member 8 of the coaxial line is made coextensive with the inner member 9 of the output system. The member 9 is especially constructed to present a variable impedance throughout its length in a manner which will be described hereinafter. The output system including the extension of the magnetron anode and the inner member 9 may be considered as a transducer unit between the magnetron and its coaxial transmission line.

The inner member 9 is received within a conical chamber 10 in the outer member diverging outwardly from a minimum diameter at its inner end, adjacent to the resonator space, to a maximum diameter equal to the integral diameter of the outer member 7 of the coaxial line at or near its point of junction with the output system. The member 9 is constructed to present a varying diameter which in turn varies the impedance it presents along its length. For example, the impedance may vary from 14 ohms at its inner end to 52 ohms which is that of the coaxial line. By controlling the outline curve of the member 9 the desired gradual change in impedance from the small end of the conical chamber to a plane at or beyond the outer end of the chamber is obtained. The final matching of impedance to the coaxial line as shown in Fig. 1 is done by gradually conforming the diameter of the member 9 to that of the member 8 of the coaxial line.

The extreme inner end of the member 9 has a short cylindrical portion 11 which enters a complementary cylindrical aperture in the anode body opening into the resonator space of the magnetron. The portion 11 desirably terminates at the outer wall 12 of the resonator space and has integrally connected thereto a segment 13 which desirably is the same size and shape as the other segments 3 of the resonator system. The segment 13 is integrally connected to the inner end face of the section 11 of the member 9. Thus the coaxial line inner member 8, the member 9 and segment 13 constitute an integral structure which is supported in spaced relation to and within the outer member 7 of the coaxial line and the outer member 14 of the output system.

The member 9 may be held in spaced relation to the outer member 14 of the output system in any suitable manner. As shown, herein, a plurality of small blocks of quartz 15 are inserted in the periphery in the inner end of member 9. The blocks 15 extend into engagement with the surface of the outer member 14 as shown in detail in Fig. 2. Thus the inner member is held concentrically within the outer member in a manner which will withstand a maximum output current without disintegration or damage to the structure.

Desirably at or near the outer end of the member 9 a seal 16 is provided which supports the member 9 and also functions to isolate the vacuum space within the magnetron from the air filled coaxial line. Desirably a heat resisting ceramic material is used for the seal. If desired means may be provided for cooling the member 9 while the device is operated at full power. This may be done in any desired manner such as that shown in the drawings in Fig. 1 wherein the member 9 is provided with interconnected water cooling channels 17 extending longitudinally thereof. The channels 17 are desirably extended outwardly to a point beyond the vacuum space of the magnetron and are connected to inlet and outlet water feeding tubes 18. The water feeding tubes may be made of glass or other ceramic material.

The form of the invention shown in Fig. 1 provides a physically long output system wherein the impedance may be made to change at a gradual rate determined by the length of the member 9. As above stated, change of impedance can be made to follow a pattern represented by the contour of the curve.

In Figs. 3 and 4 a slightly different form of the invention is shown. In this construction the variable portion of the output system is relatively short. This construction may be used where it may be desirable to conserve space. The member 19 corresponding to the member 9 in the other form of the invention is made relatively short and consequently causes a more abrupt change in impedance throughout its length. In this short form of output system the change in impedance due to the member 19 covers a reduced range of frequencies. To cover the complete range of desired change of impedance, additional means are employed in the form of a sharp reduction in diameter of the member 19 at its junction with the inner member 8 of the coaxial transmission line. The shoulder 20 acts to transform the impedance of the member 9 to that of the coaxial line. This construction provides for a section 21 of the conductor 19 having a uniform diameter. A glass or other ceramic vacuum seal is located at a position along this section where it will cause a minimum of dielectric loss thus contributing to the overall efficiency of the magnetron.

In the form of the invention shown in Figs. 3 and 4 a supporting structure for the inner end of the inner member 19 is shown which also functions as a cooling means. A pair of quarter wave stubs 22 project radially from the outer member of the output system and have metallic water circulating tubes 23 extending inward and connected to the member 19 which is provided with a cooling channel 24 through which the cooling water enters from one tube and leaves through the other. The tubes are rigidly connected to the inner member and serve to support it in spaced relation to the outer member.

What is claimed is:

1. In combination with a coaxial transmission line a magnetron having an internal resonator system presenting an anode structure having a plurality of resonator cavities separated by radially disposed anode segments and a cathode supported centrally between the inner ends of said segments; a power output system for the magnetron comprising an outer hollow conductor integrally connected to said anode structure and opening into the resonator space thereof, said hollow conductor being aligned with said coaxial line, an inner member for said output system coupled to the inner member of said coaxial line and supported in spaced relation to said outer member of said output system with the face of its inner end disposed substantially in alignment with the outer wall of said resonator space and having one of said resonator segments connected to and supported solely thereby.

2. In combination with a coaxial transmission line a magnetron having an internal resonator system presenting an anode structure having a plurality of resonator cavities separated by radially disposed anode segments and a cathode supported centrally between the inner ends of said segments; a power output system for said magnetron including power extracting means having an inner conductor and an outer hollow conductor, the latter opening into said resonator space, said outer conductor being aligned and coupled at its outer end to the outer member of said coaxial line, said inner conductor being coupled to the inner member of said coaxial line and supported in spaced relation to said outer member and having one of the segments of said resonator system connected to and supported solely thereby, said inner conductor having a conformation relative to the outer member to provide a constantly changing reactance to the passage of power from the magnetron to the coaxial transmission line.

3. In combination with a coaxial transmission line a magnetron having an internal resonator system presenting an anode structure having a resonator space including a plurality of resonator cavities separated by radially disposed anode segments and a cathode supported centrally between the ends of said segments; a power output system for the magnetron comprising an inner conductor, a hollow outer conductor opening into said resonator space surrounding and held in spaced relation to said inner conductor, each conductor being connected respectively to the inner and outer conductors of said coaxial transmission line, said inner conductor having a contour coordinated with the chamber of said outer member to present an impedance varying smoothly according to a predetermined pattern involving curved contours for at least one of said conductors from a minimum at its inner end to a value substantially matching that of said coaxial line and a conductor connected to the inner end of said inner conductor and supported solely thereby said conductor extending into said resonator chamber between an adjacent pair of resonator cavities and constituting one of said segments.

4. A power output system having the elements defined in claim 3 and in which said inner and outer conductors present an impedance varying from a minimum at their inner end to a value substantially matching that of the coaxial line and changing with distance at an exponential rate.

5. An output system for high frequency magnetrons as defined in claim 2 in which the inner and outer conductors of said output system present a varying impedance along the length thereof and in which at least one of said conductors varies its impedance changing diameter to present a smoothly curved outline ending outwardly tangently to the uniform diameter of the coaxial element to which it is coupled.

6. In combination with a coaxial transmission line magnetron having an internal resonator system presenting an anode structure having a plurality of resonator cavities separated by radially disposed anode segments and a cathode supported centrally between the inner ends of said segments; a power output system for said magnetron including power extracting means having an inner conductor and an outer hollow conductor, the latter opening into said resonator space, said outer conductor being aligned and coupled at its outer end to the outer member of said coaxial line, said inner conductor being coupled to the inner member of said coaxial line and supported in spaced relation to said outer member and having one of the segments of said resonator system connected to and supported thereby, a vacuum sealing means adjacent the plane of coupling between the said power output system and the coaxial line separating the evacuated magnetron cavities from the air-filled line, said inner and outer conductors of said output system presenting a varying impedance along the length thereof, and in which the impedance from the inner end of the system to the vacuum sealing means changes by a value less than that required for matching said coaxial line, and an abrupt transforming means outside said vacuum seal to finally match the line impedance and wherein the initial impedance change is obtained by varying the diameter of the inner conductor to present a smoothly curved outline.

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