May 27, 1958 A. D. LA RUE 2,836,764

MAGNETRON OUTPUT COUPLING DEVICES

Filed Jan. 29, 1952

FIG. 1

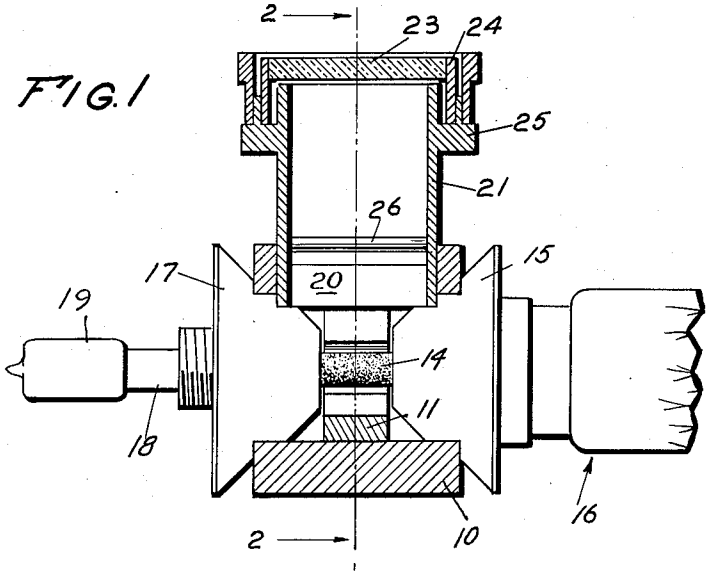
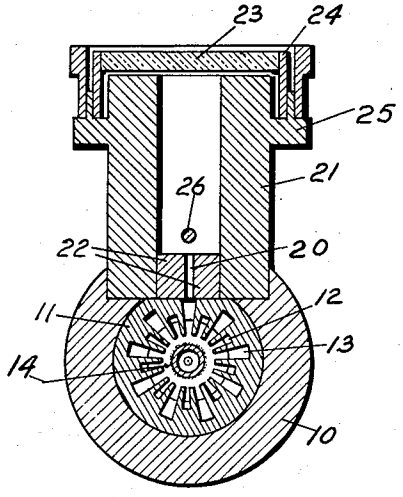


FIG. 2



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MAGNETRON OUTPUT COUPLING DEVICES

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6 Claims. (Cl. 315—39)

This invention relates to magnetron oscillators and more particularly to an improved output coupling device therefor.

It is well known that magnetron oscillators may have output coupling devices wherein a slot or other aperture extends from a cavity through the anode structure to a wave guiding section in which is positioned a window which is substantially transparent to radiant energy at the operating frequency of the magnetron.

This invention discloses that such a window will upon operation of the device for a considerable period of time become coated with a layer of metal which is produced by deposit of particles evaporated or eroded from other portions of the tube. Such a coating decreases the coupling efficiency of the window through which power is extracted from the magnetron. In addition, the impedance match between the output load and the magnetron is affected, thereby creating undesirable operating conditions for the magnetron.

This invention discloses that coating of the output window may be substantially reduced or eliminated during long periods of operation of the magnetron device by masking the window from the remainder of the tube structure, particularly the internal portions of the tube structure which are operating at elevated temperatures or are subjected to severe bombardment either by electrons or stray ions generated by collision of the electrons with any gaseous media in the device.

Specifically where the aperture connecting the interior of the magnetron with the wave guide is a slot extending from an anode cavity through the anode to the wave guide, the masking device may be a rod positioned in the wave guide beyond the end of the slot and substantially parallel to the longitudinal axis thereof. The diameter of the rod may be on the same order of magnitude as the width of the slot and may be spaced sufficiently from the end of the slot to prevent undesirable loading of the end of the slot. For any particular set of dimensions it has been found that the rod may be adjusted to a point where it will produce substantially no effect on the impedance-matching characteristics of the output coupling device. Since the masking rod is made of conductive material, further deposits of metal on the rod produce no change in the impedance-matching characteristics of the output device.

Other and further objects and advantages of this invention will be apparent as the description thereof progresses, reference being had to the accompanying drawing wherein:

Fig. 1 illustrates a longitudinal cross-sectional view of a magnetron having an output coupling structure embodying this invention; and

Fig. 2 illustrates a transverse cross-sectional view of the device shown in Fig. 1 taken along line 2—2 of Fig. 1.

Referring now to Figs. 1 and 2, there is shown a magnetron oscillator having an anode block **10** of conductive material. Anode block **10** has a substantially cylindrical space therein which contains the anode structure proper. The particular anode structure illustrated herein comprises a rising-sun type of cavity resonator wherein alternate cavities are made of different depths. As is illustrated herein, the cavities are cut into an anode ring **11** positioned in the cylindrical opening in anode block **10**. One set of anode cavities **12** is relatively small and does not extend very far from the inner edge of the anode ring **11** radially toward the anode block **10**. The other set of anode cavities **13**, which are positioned in between each pair of cavities **12**, extends for a greater distance to anode block **10**. The inner ends of the cavities **12** and **13** terminate on the same cylindrical locus which is coaxial with the cylindrical space cut in anode block **10** in which the anode ring and cavities **12** and **13** are positioned.

Positioned within the space defined by the inner ends of the anode cavities **12** and **13** and spaced from the anode structure is a cathode **14**. Cathode **14** is shown here by way of example only and a more complete description of this particular cathode may be had by referring to copending application, Serial No. 201,219 filed December 16, 1950 by Leo J. Cronin, now Patent No. 2,682,511, dated June 29, 1954. The supporting and lead-in structure for cathode **14** passes through a pole piece **15**, which is sealed to one end of the cylindrical aperture in anode block **10**. The lead-in and supporting structure of cathode **14** after passing through pole piece **15** is insulatingly supported with respect to pole piece **15** by an insulating seal partially shown at **16**. Insulating seal **16** may be of any desired type well known in the art. The opposite end of the cylindrical opening in the anode block **10** from that sealed by pole piece **15** is sealed by pole piece **17** which has an aperture therein to which is attached a tube **18** used for evacuating the interior of the magnetron. After evacuation the end of the tube **18** is sealed by a mass of glass **19**. A magnetic field is produced across the space between the cathode **14** and the anode structure through a magnet connected to magnetic pole pieces **15** and **17** in a well-known manner, not illustrated herein.

The particular details of the magnetron disclosed so far are well known and any desired magnetron, such as a conventional strapped or unstrapped magnetron anode structure, may be substituted therefor.

An output coupling device is provided comprising a slot **20** extending outwardly from the outer end of one of the large cavities **13** through anode ring **11** and anode block **10**. Slot **20** opens into one end of a wave guide **21**, shown here, by way of example, as being metallic and having a rectangular cross-section. Aside from slot **20**, the end of wave guide **21** into which slot **20** opens is blocked by conductive members **22**. The length of slot **20** may be made substantially a quarter wave length long in the direction radial to the cylindrical aperture in anode block **10** and parallel to the major axis of wave guide **21**, thereby acting as a quarter wave transformer. By adjustment of the dimensions of slot **20**, the impedance of the anode structure may be matched to the impedance of the wave guide **21** and the load, not shown, which is fed by wave guide **21**. The dimension of the slot parallel to the axis of the cylindrical opening in anode block **10**, cathode **14** and the magnetic field in the magnetron is made substantially greater than a half wave length long. If this dimension of the slot were less than a half wave length long, the slot would behave as a wave guide whose dimensions were less than those required for propagation of a wave therein. For good design this dimension of the slot may be such that the ratio of the cut-off frequency of the slot **20** to the operating frequency of the device is in the range from .4 to .7.

A ceramic window **23** is positioned at the end of the wave guide **21** from the slot **20**, ceramic window **23** be-

ing, for example, spaced slightly from the end of wave guide 21 and sealed to a metal cylinder 24 which surrounds the end of wave guide 21 and is sealed to a lip 25 attached to the exterior edge of wave guide 21.

Positioned in the wave guide 21, adjacent slot 20 and parallel to the elongated aperture presented thereby to the wave guide 21, is a conductive rod 26 which is attached to the side walls of wave guide 21. As shown here rod 26 has a diameter slightly greater than the thickness of slot 20 and is spaced from the end of slot 20 by something greater than the diameter of rod 26. By adjustment of the position of rod 26, together with the other dimensions of the output coupling device including the wave guide 21 and the slot 20, a good impedance match may be achieved between the magnetron, anode and the load, not shown, which is fed from the wave guide 21 through the window 23.

Since the rod 26 blocks the straight line path between slot 20 and the portion of the window 23 exposed to the wave guide 21, any metallic material passing through the slot 20 from the interior of the magnetron will impinge on rod 26 and be collected thereby. As a result, substantially all of the conductive material passing through slot 20 is prevented from collecting on the ceramic window 23.

This completes the description of the particular embodiment of the invention illustrated herein. However, many modifications thereof will be apparent to persons skilled in the art without departing from the spirit and scope of this invention. For example, the slot 20 may be an aperture of any shape. For example, it may be the well-known H-shape coupler or a cylindrical hole or any other desired shape. In such cases the best configuration for the masking rod 26 may be found by experimentation, and will approach the shape of the aperture. Therefore, it is desired that this invention be not limited to the particular details illustrated herein except as defined by the appended claims.

What is claimed is:

1. An electron discharge device for producing high frequency radiant energy comprising an evacuated envelope, an anode structure including an outer member forming a portion of said envelope and a plurality of anode elements extending inwardly from said outer member, said anode elements combining with the outer member to form within said envelope a plurality of cavity resonators, a cathode spaced from said anode elements, an output waveguide having one end connected to said anode structure, an electrically-insulating seal transparent to said radiant energy disposed in the other end of said waveguide, said waveguide being coupled to one only of said cavity resonators by means of an iris extending from within said envelope through said outer member and a masking element substantially opaque to said radiant energy disposed within said waveguide in substantial alignment with said iris between said iris and said seal.

2. An electron discharge device for producing high frequency radiant energy comprising an evacuated envelope, an anode structure including an outer member forming a portion of said envelope and a plurality of anode elements extending inwardly from said outer member, said anode elements combining with the outer member to form within said envelope a plurality of cavity resonators, a cathode spaced from said anode elements, means adjacent said anode structure for producing a magnetic field transverse to the direction of motion of electrons from said source towards said anode structure, an output waveguide having one end connected to said anode structure, an electrically-insulating seal transparent to said radiant energy disposed in the other end of said waveguide, said waveguide being coupled to one only of said cavity resonators by means of an iris extending from within said envelope through said outer member and a masking element substantially opaque to said radiant energy disposed within said waveguide in substantial alignment with said iris between said iris and said seal.

3. An electron discharge device for producing high frequency radiant energy comprising an evacuated envelope, an anode structure including an outer member forming a portion of said envelope and a plurality of anode elements extending inwardly from said outer member, said anode elements combining with the outer member to form within said envelope a plurality of cavity resonators, a cathode spaced from said anode elements, means adjacent said anode structure for producing a magnetic field transverse to the direction of motion of electron from said source towards said anode structure, an output waveguide having one end connected to said anode structure, an electrically-insulating seal transparent to said radiant energy disposed in the other end of said waveguide, said waveguide being coupled to one of said cavity resonators by means of an iris extending from within said envelope through said outer member and a masking element substantially opaque to said radiant energy disposed within said waveguide in substantial alignment with said iris between said iris and said seal.

4. An electron discharge device for producing high frequency radiant energy comprising an evacuated envelope, an anode structure including an outer member forming a portion of said envelope and a plurality of anode elements extending inwardly from said outer member, said anode elements combining with the outer member to form within said envelope a plurality of cavity resonators, a cathode spaced from said anode elements, means adjacent said anode structure for producing a magnetic field transverse to the direction of motion of electrons from said source towards said anode structure, an output waveguide having one end connected to said anode structure, an electrically-insulating seal transparent to said radiant energy disposed in the other end of said waveguide, said waveguide being coupled to one of said cavity resonators by means of an iris extending from within said envelope through said outer member and an electrical conductive masking element substantially opaque to said radiant energy disposed within said waveguide in substantial alignment with said iris between said iris and said seal.

5. An electron discharge device for producing high frequency radiant energy comprising an evacuated envelope, an anode structure including an outer member forming a portion of said envelope and a plurality of anode elements extending inwardly from said outer member, said anode elements combining with the outer member to form within said envelope a plurality of cavity resonators, a cathode spaced from said anode elements, means adjacent said anode structure for producing a magnetic field transverse to the direction of motion of electrons from said source towards said anode structure, an output waveguide having one end connected to said anode structure, an electrically-insulating seal transparent to said radiant energy disposed in the other end of said waveguide, said waveguide being coupled to one only of said cavity resonators by means of an iris extending from within said envelope through said outer member and an electrical conductive masking element substantially opaque to said radiant energy disposed within said waveguide in substantial alignment with said iris between said iris and said seal and arranged substantially parallel to said cathode.

6. An electron discharge device for producing high frequency radiant energy comprising an evacuated envelope, an anode structure including an outer member forming a portion of said envelope and a plurality of anode elements extending inwardly from said outer member, said anode elements combining with the outer member to form within said envelope a plurality of cavity resonators, a cathode spaced from said anode elements and disposed along the longitudinal axis of said device, means adjacent said anode structure for producing a

magnetic field transverse to the direction of motion of electrons from said source towards said anode structure, an output waveguide having one end connected to said anode structure, an electrically-insulating seal transparent to said radiant energy disposed in the other end of said waveguide, said waveguide being coupled to one of said cavity resonators by means of an iris extending from within said envelope through said outer member, and a masking element of cross section greater than the cross section of said iris in the plane transverse to said longitudinal axis substantially opaque to said radiant energy disposed within said waveguide in substantial alignment with said iris between the iris and said seal.

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