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PROTECTIVE MEANS FOR ELECTRON DISCHARGE DEVICES

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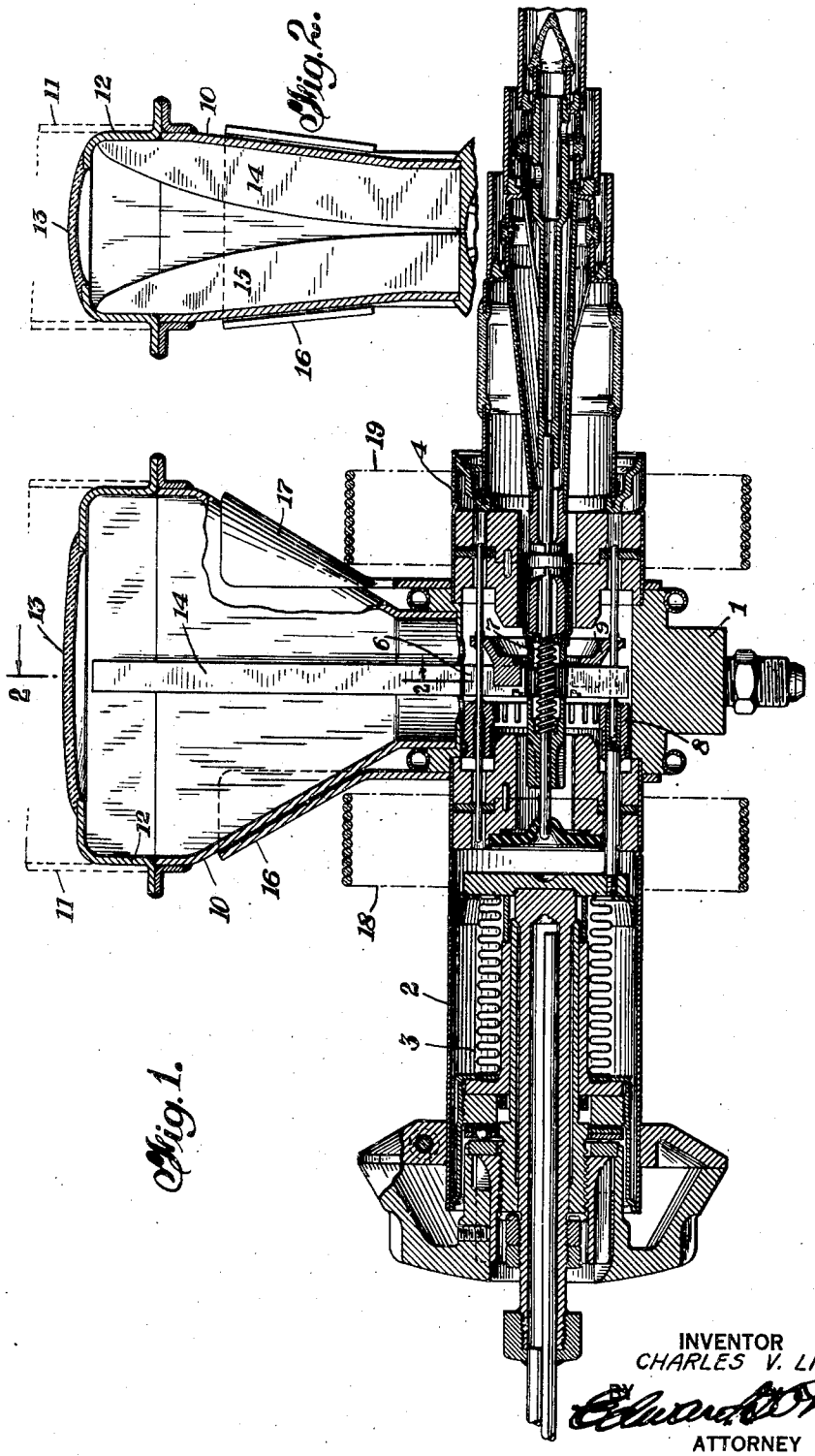


Fig. 1.

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PROTECTIVE MEANS FOR ELECTRON DISCHARGE DEVICES

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4 Claims. (Cl. 250—27.5)

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This invention relates to magnetrons or similar electron discharge tubes and in particular to magnetrons of the cavity resonator type wherein the cavities are coupled to the load circuit through an impedance transformer and a wave guide.

In magnetrons of the above type it is conventional to extract the generated high frequency energy from the magnetron cavities at a point of maximum current density and minimum potential, i. e., a point of low impedance. A rectangular wave guide operating on the $TE_{1,0}$ mode (which is conventional in applications of this type) has a ratio of electric to magnetic field intensities which is much greater than the ratio of like fields at the point of low impedance in the magnetron cavities. It is therefore desirable to couple the wave guide to the magnetron cavities through an impedance matching transformer to avoid reflections of the transmitted wave.

The impedance matching transformer is preferably of the form of a diverging line whose impedance varies substantially exponentially from its low impedance to its high impedance end. The transformer is contained in an evacuated horn shaped member which is structurally part of the magnetron. A glass or other insulating window separates the vacuous space of the magnetron from the nonvacuous space of the wave guide.

It has been found that in the operation of the magnetron there is a tendency for free electrons to escape from the magnetron resonating cavities and to be projected at high velocity in a hypocycloidal motion through the impedance transforming member toward the insulating window. Should these electrons strike the window, intense local heating of the window occurs, resulting in "suck-in" and damage to the magnetron. It is also possible that the heating of the window may be due, in part at least, to positive ions produced by the impact of electrons against gas molecules in their travel toward the window.

In accordance with my invention I provide a magnetic field across the vacuous space of the horn shaped member, said field having a direction which is substantially perpendicular to the motion of the electrons. This magnetic field causes the electrons to follow a path which curves away from the window and to strike harmlessly against the walls of the horn-shaped member.

It is the primary object of my invention to prevent the aforesaid bombardment of the insulating window and to thereby preserve the magnetron from damage.

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Other objects and features of my invention will be apparent from the specification and claims together with the attached drawing of which:

Fig. 1 is a cross-sectional view of a plural cavity magnetron, the section being taken through what is essentially the longitudinal axis of symmetry of the magnetron and showing the cavities and tuning elements in their relation to the horn-shaped impedance transforming member and the means for preventing electronic bombardment of the window.

Fig. 2 is a partial view looking toward the plane perpendicular to the axis of symmetry at the section 2—2 of Fig. 1. The figure shows essentially the shape of the diverging line constituting the impedance transforming member.

Referring to Fig. 1 the reference character 1 represents the body of a magnetron to which other parts are brazed or otherwise suitably fastened to form a structure capable of being evacuated. The extension or housing 2 positioned on one side of the body incloses an assembly 3 for adjusting the frequency to which the magnetron may be tuned. This adjusting mechanism is not part of my invention and therefore will not be described herein. If a description of its operation is desired reference is made to my application, Serial Number 626,130, entitled "Adjustable magnetron" and filed November 1, 1945.

On the opposite side of the body from the extension 2 another extension 4 mounts the cathode electrode and its supporting structure. This structure is described and claimed in a separate application entitled "Cathode support" and filed November 1, 1945, Serial No. 626,132, which now is U. S. Patent 2,474,263 issued June 28, 1949.

The resonant cavities of the magnetron are formed by a plurality of vanes 6, radially positioned within the magnetron body and symmetrically disposed about the cathode 7. The operation of a plural cavity magnetron is well known to one skilled in the art and will not be described in detail here. However, in a magnetron of the type in which the frequency may be varied means are provided to vary the tuning of the resonant cavity formed by the vanes 6. Two types of tuning means may be employed, one for varying the inductive reactance of the resonant cavities, the other for varying the capacitive reactance thereof. The inductive reactance tuning means comprises an L-ring 8 while the capacitive reactance

tuning means comprises a C-ring 9. Both the L-ring and C-ring are described in my application Serial Number 626,131, entitled "Reactance tuning device" filed November 1, 1945, in which the C-ring structure is specifically claimed.

Referring now to that part of the magnetron to which my present invention is directed, and to both Figs. 1 and 2, an evacuated horn-shaped member 10 is positioned between the body 1 and a wave guide 11. The wave guide may be of considerable length so only that portion which is adjacent the horn-shaped member is illustrated in the drawing. A load circuit, not shown, is connected to the other end of the wave guide. The construction of a wave guide for a particular frequency or for a small range of frequencies is well known in the art and a description thereof is therefore unnecessary. The member 10 is closed at its enlarged end by a closure member 12, the two members being welded together around the periphery of suitable flanges which are formed integrally with the members.

A glass or other type of non-conducting window 13 is sealed over an opening in the closure member 12. This permits the magnetron to be evacuated while at the same time allows the wave energy developed in the cavities of the magnetron to pass from the horn or transformer 10 into the wave guide. The window is preferably of an elliptical shape and so dimensioned that at approximately the mean frequency to which the magnetron may be tuned it represents a substantially infinite or at least a very high impedance across the wave guide and therefore does not materially influence the operation of the system.

Within the member 10 are two ramps 14 and 15, the surfaces of which diverge exponentially and constitute a transmission line of gradually increasing impedance between the cavities of the magnetron and the wave guide. The impedance of the line adjacent the resonant cavities of the magnetron is low and substantially matches the impedance of the cavities. The impedance of the line at its outer end is such that it substantially matches the impedance of the wave guide 11. It will be observed that the dimensions of the open end of the horn and of the wave guide are substantially the same. This permits a gradual change of impedance between these two members inasmuch as surfaces of the ramps are widely spaced at this point.

As aforesaid it has been found that during magnetron operation there are occasions when free electrons escape from the cavity of the magnetron to the space within the horn 10. If these electrons strike the window with sufficient velocity the window becomes softened by overheating and failure due to suck-in will occur. In order to prevent such failure, two magnetic shoes 16 and 17 are positioned one on each side of the horn as shown in Fig. 1. The magnetron shoes are energized from the field coils 18 and 19 which also supply the magnetic field for the operation of the magnetron as is well understood. The magnetic shoes are so positioned with respect to the horn that a deflecting field is produced across the shoes substantially at right angles to the path of the free electrons. The field deflects the electrons causing them to impinge on the inner surface of the horn where their energy is harmlessly dissipated.

Although I have illustrated only a single embodiment of my invention, other modifications will be apparent to one skilled in the art and it is my intention that the scope of my invention be limited only by the objects thereof and the appended claims. For example, the magnetic shoes for deflecting the electrons could be permanent magnets suitably associated with the evacuated horn shaped member, or an electromagnetic field could be produced by suitably energized coils distinct from the field coils 18 and 19.

What is claimed is:

1. Protective means for the output coupling means for a magnetron with field poles used as a source of electromagnetic waves and undesired stray electrons, said magnetron including an evacuated member and insulating window closing one end of said member, said waves travelling through said window, said protective means comprising electromagnetic means mounted adjacent said evacuated member for producing a magnetic field transverse to the direction of travel of said waves through said window and energizing means associated with said electromagnetic means for causing stray electrons to be deflected away from said window.

2. The combination claimed in claim 1 wherein said means for producing said magnetc field comprises a pair of magnetic shoes disposed exterior to and on opposite sides of said evacuated member, said magnetic shoes being positioned to be magnetically connected to the field of the poles of said magnetron.

3. Protective means for the output coupling means of a magnetron which includes field poles, an evacuated envelope, a plurality of cavity resonators mounted therein, an impedance transformer coupled at one end to one of said resonators and having a window at the opposite end through which electromagnetic waves from said resonators travel, and divergent ramps mounted in said transformer in a plane parallel to the direction of travel of said waves, said protective means comprising electromagnetic means mounted adjacent said transformer for producing a magnetic field transverse to the direction of travel of said waves through said window and energizing means associated with said electromagnetic means for causing stray electrons to be deflected away from said window.

4. Protective means according to claim 3 in which said means for producing said magnetic field comprises a pair of magnetic shoes fitting closely about said impedance transformer and mounted closely adjacent thereto and on opposite sides of the plane containing said ramps and means for magnetically connecting said magnetic shoes to the field poles of said magnetron.

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